

# MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

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Vol. XLI      NOVEMBER-DECEMBER, 1949      No. 6

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## CONTENTS

Western Fungi-I.....	WM. BRIDGE COOKE 601
Studies on Rocky Mountain Fungi-I.....	W. G. SOLHEIM 623
Mineral oil and preservation of fungous cultures MARY E. STEBBINS AND WILLIAM J. ROBBINS 632	
New cellulose destroying fungi isolated from military material and equipment.....	L. M. AMES 637
Wynnea americana.....	RICHARD P. KORY 649
Cyathus vernicosus, another tetrapolar Bird's Nest Fungus HAROLD J. BRODIE 652	
Studies in the genus Otidea.....	BESSIE B. KANOUSE 660
A new species of Achlya with coiled oogonial stalks T. W. JOHNSON JR. 678	
Studies on some unusual Heterobasidiomycetes from Wash- ington State.....	GEORGE NYLAND 686
Notes and brief articles.....	702

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## TABLE OF CONTENTS

### No. 1. JANUARY-FEBRUARY

Observations on <i>Streptomyces griseus</i> . III. Carbon sources for growth and Streptomycin production, EUGENE L. DULANEY .....	1
The Albert Commons Collection of Fungi in the Herbarium of the Academy of Natural Sciences in Philadelphia, DAVID R. SUMSTINE .....	11
Species of <i>Synchytrium</i> in Louisiana. V. A new species on <i>Sambucus canadensis</i> , MELVILLE T. COOK .....	24
<i>Olpidiopsis Schenkiana</i> and its hyperparasite <i>Ectrogella Besseyi</i> n. sp., F. K. SPARROW AND BERNARD ELLISON .....	28
Keys to the Orders, Families, and Genera of the Gastromycetes, S. M. ZELLER .....	36
The species of <i>Tympanis</i> occurring on <i>Pinus</i> , J. WALTON GROVES AND A. MAVIS LEACH .....	59
The Genus <i>Ceracea</i> Cragin, G. W. MARTIN .....	77
Notes and brief articles .....	87

### No. 2. MARCH-APRIL

A revision of the classification of the ascomycetes with special emphasis of the pyrenomycetes, JULIAN H. MILLER .....	99
The dual phenomenon and <i>Trichophyton mentagrophytes</i> , WILLIAM J. ROBBINS AND ILDA McVEIGH .....	128
The swarm-cells of myxomycetes, EUGENE W. ELLIOTT .....	141
A new aquatic species of <i>Pythium</i> , ADRIAN W. POITRAS .....	171
Preservation of saprolegniaceae by the mineral oil method, HELEN SIMPSON REISCHER .....	177
Conidia-like structures in <i>Plectania coccinea</i> , CONST. J. ALEXOPOULOS AND ED. E. BUTLER .....	180
<i>Crebrothecium Ashbyi</i> , JOHN B. ROUTIEN .....	183
The influence of concentrations of nutrients, thiamin, and biotin upon growth, and formation of perithecia and ascospores by <i>Chaetomium convolutum</i> , VIRGIL GREENE LILLY AND H. L. BARNETT .....	186
Downy mildew of <i>Urtica</i> in the United States, CHARLES GARDNER SHAW .....	197
The <i>Helminthosporium</i> on <i>Buchloe dactyloides</i> , C. L. LEFEBVRE AND A. G. JOHNSON .....	202
Notes and brief articles .....	207

### No. 3. MAY-JUNE

William Henry Long, 1867-1947, JOHN A. STEVENSON .....	223
An <i>Endocochlus</i> having binary helicoid thalli of left-handed rotation, CHARLES DRECHSLER .....	229

A second contribution to the knowledge of the ustilaginales of China, LEE LING .....	252
A new <i>Olpidiopsis</i> parasite of <i>Karlingia rosea</i> from Maryland, JOHN S. KARLING .....	270
Concerning the identity of Iterson's cellulolytic <i>Mycogone</i> , WILLIAM W. DIEHL .....	277
<i>Colus Schellenbergiae</i> again, W. C. COKER AND G. C. REBELL .....	280
Notes on some species of <i>Phakopsora</i> and <i>Angiopsora</i> , M. J. THIRUMA- LACHAR AND FRANK D. KERN .....	283
Pigment production in the differentiation of <i>Trichophyton mentagro- phytes</i> and <i>Trichophyton rubrum</i> , FLORANTE C. BOCOBO, M.D., AND RHODA W. BENHAM, Ph.D. ....	291
New species of <i>Torrubiella</i> , <i>Hirsutella</i> and <i>Gibellula</i> , E. B. MAINS ....	303
Phase-determining factors in <i>Blastomyces dermatitidis</i> , S. B. SALVIN	311
The perfect state of the fungus causing spot anthracnose of <i>Arbutus</i> Unedo L., G. ARNAUD AND A. A. BITANCOURT .....	320
Nomenclatorial problems in the <i>Peronosporaceae</i> , CHARLES GARDNER SHAW .....	323
A new species of <i>Achyla</i> , HELEN SIMPSON REISCHER .....	339
Two species representing a new genus of the <i>Chaetomiaceae</i> , R. K. BENJAMIN .....	346
Notes and brief articles .....	355

## No. 4. JULY-AUGUST

Sanford Myron Zeller, HELEN M. GILKEY .....	357
A nematode-capturing fungus with anastomosing clamp-bearing hyphae, CHARLES DRECHSLER .....	369
Observations on <i>Streptomyces griseus</i> . IV. Induced mutation and strain selection, EUGENE L. DULANEY, MYRLE RUGER AND CHARLES HLAVAC .....	388
The effect of temperature on the papillation of oogonia of <i>Achyla</i> <i>colorata</i> , HELEN SIMPSON REISCHER .....	398
Amino acids in the biosynthesis of penicillin, FREDERICK T. WOLF ....	403
Chromosome numbers in the <i>Hypocreaceae</i> , HILDE E. HIRSCH, WILLIAM C. SNYDER AND H. N. HANSEN .....	411
An undescribed species of <i>Perioconia</i> , C. L. LEFEBVRE, A. G. JOHNSON AND HELEN S. SHERWIN .....	416
A cytological study of typical and atypical basidial development in <i>Gymnosporangium clavipes</i> , LINDSAY S. OLIVE .....	420
The taxonomy of <i>Septobasidium Polypodii</i> and <i>S. album</i> , J. N. COUCH	427
<i>Oxyporus nobilissimus</i> and the genus <i>Oxyporus</i> in North America, WM. B. COOKE .....	442
Schweinitz-Fries Letters, C. L. SHEAR .....	456
The genus <i>Gomphidius</i> Fries in North America, ROLF SINGER .....	462
Notes and brief articles .....	490

# TABLE OF CONTENTS

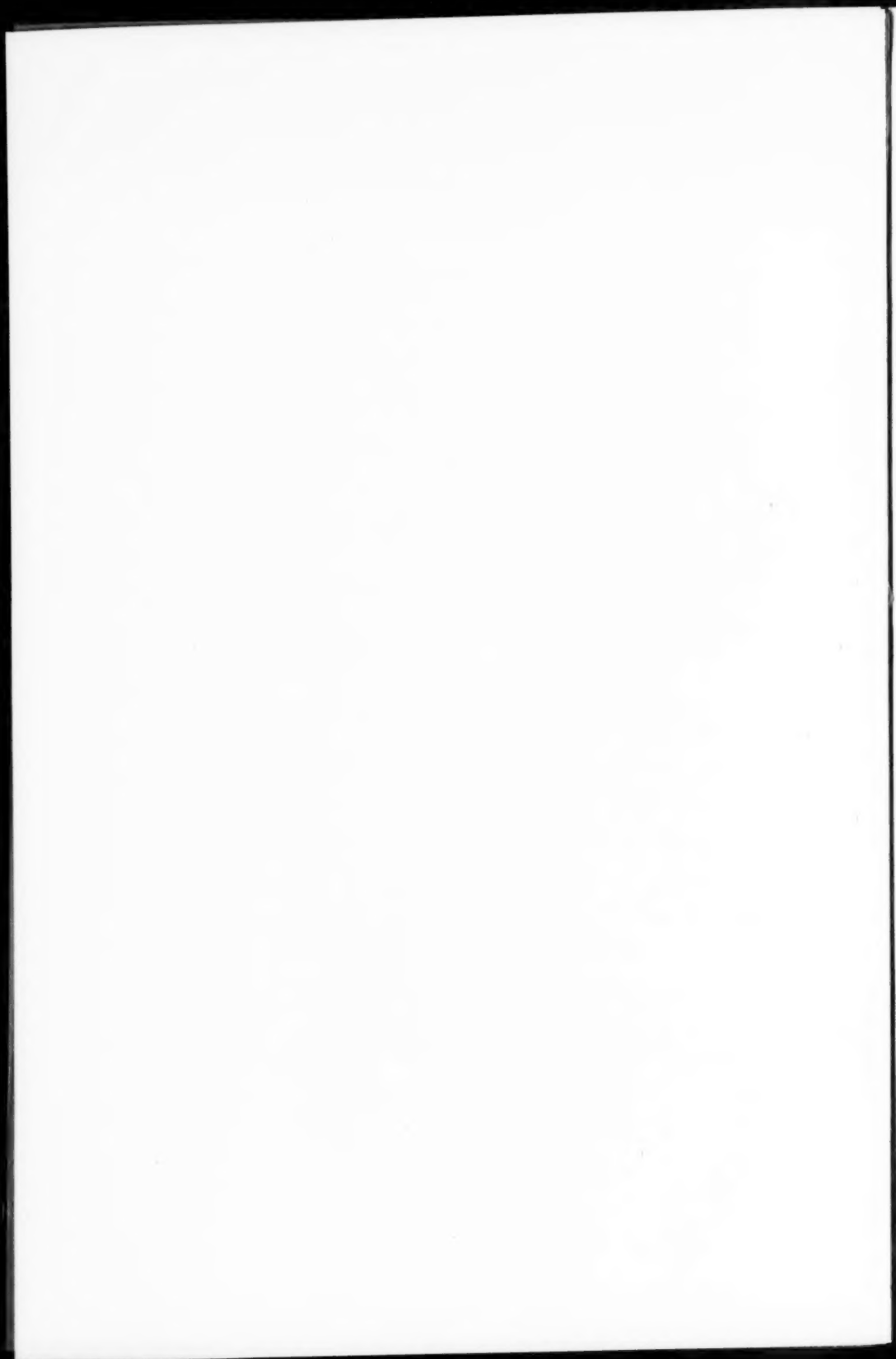
v

## NO. 5. SEPTEMBER-OCTOBER

Some leafspot fungi on western Gramineae, RODERICK SPRAGUE .....	493
New monocentric eucarpic operculate chytrids from Maryland, JOHN S. KARLING .....	505
The taxonomic significance of sporogenous basal cells in the Uredinales, M. J. THIRUMALACHAR AND GEORGE B. CUMMINS .....	523
The genus <i>Heterochaete</i> in the United States, SISTER MARY CECILIA BODMAN .....	527
Catacauma sabal Chardon identified in the United States and Mexico, DONALD P. LIMBER AND ANNA E. JENKINS .....	537
Weedon's Myriangium on Sabal, DONALD P. LIMBER AND ANNA E. JENKINS .....	545
Studies on the morphology and cytology of <i>Thielavia basicola</i> Zopf, GEORGE BLANCHARD LUCAS .....	553
Two unusual conidial fungi, FREDERICK A. WOLF .....	561
Studies in the genus <i>Pleospora</i> —I, LEWIS E. WEHMEYER .....	565
Notes and brief articles .....	594

## NO. 6. NOVEMBER-DECEMBER

Western Fungi—I, WM. BRIDGE COOKE .....	601
Studies on Rocky Mountain Fungi—I, W. G. SOLHEIM .....	623
Mineral oil and preservation of fungous cultures, MARY E. STEBBINS AND WILLIAM J. ROBBINS .....	632
New cellulose destroying fungi isolated from military material and equipment, L. M. AMES .....	637
<i>Wynnea americana</i> , RICHARD P. KORB .....	649
<i>Cyathus vernicosus</i> , another tetrapolar Bird's Nest Fungus, HAROLD J. BRODIE .....	652
Studies in the genus <i>Otidea</i> , BESSIE B. KANOUSE .....	660
A new species of <i>Achlya</i> with coiled oogonial stalks, T. W. JOHNSON, JR. ....	678
Studies on some unusual <i>Heterobasidiomycetes</i> from Washington State, GEORGE NYLAND .....	686
Notes and brief articles .....	702



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## WESTERN FUNGI—I

WM. BRIDGE COOKE

(WITH 22 FIGURES)

### A. SOME MISCELLANEOUS SPECIES FROM MOUNT SHASTA

1. *PEYRONELIA SIRODESMOIDES* Cif. & Frag. In 1927 Ciferri and Fragoso proposed this genus and species for a black mold growing on rotting wood in the Dominican Republic. It was cespitose, black, woolly, had sterile creeping hyphae which were olivaceous, septate, and  $3-4.5\ \mu$  in diameter. It did not have conidiophores, or these structures were indistinct, being merely the broadened base of the primary conidium. The conidia were black, 1-8 but mostly 2-5 in a chain, fusoid, 3-10-septate,  $28-60 \times 7-15\ \mu$  (averaging  $35-45 \times 9-12\ \mu$ ), easily separating at a narrow isthmus  $2-3\ \mu$  in diameter.

On Mount Shasta a fungus was found on dead sticks of *Holodiscus discolor* var. *glabrescens* Heller which fits this description well. The spores in the chains are exogenous,  $16-43.5 \times 10-14\ \mu$ , 1-5-septate, with the isthmus between the spores  $5-6\ \mu$  in diameter. In some instances there seem to be rather distinct conidiophores.

The Mount Shasta collection was made on July 16, 1946, on a ridge north of Horse Camp at about 9000 feet elevation, W. B. Cooke 18253. Despite the wide geographic separation of these two collections there does not seem to be enough difference on which to base a specific segregation.

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October 31, 1949]

2. *ARTHRIUM BICORNE* Rostrup. Material of this species was found forming black sooty areas on dead culms of *Juncus balticus* var. *montanus* Engelm. at Horse Camp, Mt. Shasta, Siskiyou Co., Calif., June 24, 1946, W. B. Cooke 18032. Mycobiota of North America 280.

The spores are produced on erect conidiophores up to  $200\text{--}300\ \mu$  long which are divided into a number of short cells from each of which one or two spores are produced on short, lateral processes. The spores are arranged like a row of shingles on the conidiophore. The spores are black, two-horned, smooth, one-celled. Their width from tip of horn to tip of horn is  $20\text{--}40\ \mu$ ; the dimensions of the spores exclusive of the horns are  $8\text{--}13.5 \times 13.4\text{--}16.7\ \mu$ ; the horns are  $7.5\text{--}13.4 \times 2.5\ \mu$ . The specimen was identified by Lee Bonar.

3. *DENDRYPHIUM PINI* von Hoehnel. A brown mold on Shasta Fir bark is assigned to this species. On the substratum the mold develops prostrate ropes of brown hyphae. These ropes are  $50\text{--}75\ \mu$  in diam. and are composed of mostly granular incrustated hyphae  $1.5\text{--}4\ \mu$  in diameter, although a few hyphae associated with them are smooth. The smaller hyphae are paler in color. These hyphae are branched and septate. The spores remain in chains until maturity. The chains are 2–20 spores long and are usually branched. The apparently erect conidiophores have roughened walls. The spores are dark brown at maturity, and have both thick and roughened walls. At first they are light brown. They are 1-septate, finally 2–3-septate and measure  $10.5\text{--}18 \times 5.5\text{--}7\ \mu$ .

According to the description published in Saccardo (Syll. Fung. 22: 1398), the spores are  $16 \times 5.5\text{--}6\ \mu$ , 2–4-septate, finally 4-septate. One wonders if "celled" were intended instead of "septate." *Dendryphium cladosporioides* Ell. & Ev. fits this material well except that it is reported from tomato vines and was collected in Louisiana. It is possible that these three collections may represent the same species.

The Mount Shasta material was obtained from bark of *Abies magnifica* var. *shastensis* Lemmon near Horse Camp, 8000 ft., June 1946, W. B. Cooke 18078.

4. *RAMULARIA MIMULI* Ell. & Kell. Spots epiphyllous, becoming confluent, covering entire leaves and even shoots; spores hyaline, 0-3-septate,  $18-(25)-33 \times 3-4.5 \mu$ .

On *Mimulus tilingii* Regel. In the overflow of a small spring above Panther Creek Meadows, 9000 feet, White Bark Pine Zone, Aug. 29, 1946, W. B. Cooke 18426; in lower part of Panther

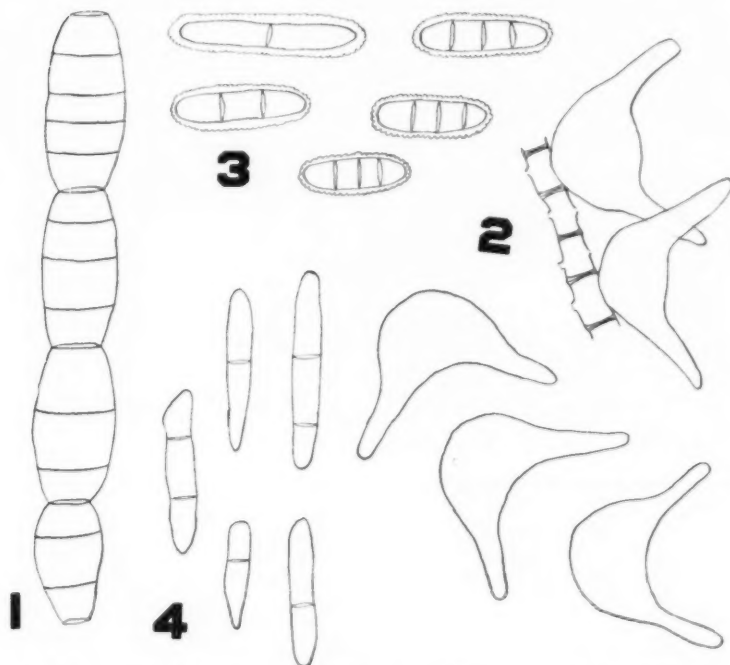


FIG. 1. Spores of *Peyronelia sirodesmoides*. FIG. 2. Spores of *Arthrinium bicorne*. FIG. 3. Spores of *Dendryphium pini*. FIG. 4. Spores of *Ramularia mimuli*.

Creek Meadows, 7000 ft., Shasta Fir Zone, Aug. 15, 1947, W. B. Cooke 20446. Distributed in *Mycobiota of North America* No. 221. Also observed in the large colony of this host around the springs above Horse Camp at 8250 ft. in the White Bark Pine Zone.

Only one species of *Ramularia* has been described on *Mimulus* in North America. It was first reported from Nebraska and the

spores from this collection were described as  $30-40 \times 3 \mu$ . A later collection from Yellowstone National Park was reported to have larger spores,  $40-96 \times 4-5 \mu$ . The above collections from Mt. Shasta have generally smaller spores than either of these specimens. It is felt that not enough material is yet available for more than mentioning the existence of this fungus complex.

5. *Ramularia claytoniae* W. B. Cooke, sp. nov. Maculis foliiculis, amphigenis, confluentibus; hyphis conidiophoris gregariis vel fasciculatis,  $15-20 \times 2 \mu$ , hyalinis; conidiis catenulatis, hyalinis,  $20-35 \times 1.5-2.5 \mu$ , 0-3-septatis.

Hab. in foliis vivis *Claytoniae sibericae*, Big Springs, prope McCloud, Siskiyou Co., Calif., Jul. 25, 1946. W. B. Cooke 18279.

Spots on leaves becoming confluent, amphigenous; conidiophores in clusters or appearing singly through the epidermis or occasionally through stomata, up to  $20 \mu$  long by  $2 \mu$  wide, hyaline; conidia in chains, hyaline,  $20-35 \times 1.5-2.5 \mu$ , 0-3-septate.

Type collected on *Claytonia siberica* L. in the overflow from the Big Springs of the McCloud River, NW 1/4, S. 14, T. 39 N., R. 2 W., Siskiyou Co., Calif., July 25, 1946, W. B. Cooke 18279.

So far as either Lee Bonar or the writer can find there is no reference in the literature to a species of *Ramularia* occurring on any member of the Portulacaceae.

6. *Ramularia pentstemonis* W. B. Cooke, sp. nov. Maculis foliiculis, epiphyllis, non vel raro confluentibus; hyphis conidiophoris fasciculatis,  $50-200 \times 3 \mu$ , hyalinis; conidiis plus minusve catenulatis, hyalinis, non septatis,  $8-18 \times 3-4.5 \mu$ .

Hab. in foliis vivis *Pentstemonis shastensis*, 1850 m., Mt. Shasta, Siskiyou Co., Calif., Jul. 18, 1947. W. B. Cooke 20207.

Spots white, scattered, surrounded by red-purple discolored areas; conidiophores hyaline, cespitose, emerging from stomata on upper surface of leaves,  $50-300 \times 3 \mu$ , breaking up into conidia, or conidia produced terminally, or in chains; conidia hyaline,  $8-18 \times 3-4.5 \mu$ , non-septate, rare in some spots, common in others. Conidiophores straight to flexuous, septate, some appearing geniculate, some occasionally branched.

Type collected in Wagon Camp Meadows, 5700 ft., Mt. Shasta, Sierra Mixed Conifer Zone, July 18, 1947, W. B. Cooke 20307. On *Pentstemon shastensis* Keck. Occasionally plants were found to be heavily infected. Excessive humidity near the base of the plants may account for the poor conidial production and the rich



conidiophoral development with some branching to be found on more basal leaves.

No records of a species of *Ramularia* on *Pentstemon* have been found in the various host indices consulted.

7. *CYLINDROSPORIUM SMILACINAE* Ell. & Ev. and *CYLINDROSPORIUM VERATRINUM* Sacc. & Wint. On neighboring colonies of the host plants, *Smilacina stellata* (L.) Desf. and *Veratrum californicum* Durand, these two fungi caused heavy infection in the summer of 1947 at Wagon Camp, 5700 ft., Mt. Shasta. Morphologically these fungi appear distinct. Cross-inoculation studies are required to determine whether they represent only different reactions of the same fungus to different hosts.

*C. smilacinae* has spores  $67-90.5 \times 2.5-3.5 \mu$ , 1-2-septate, hyaline, more or less curved, produced in large loose masses.

*C. veratrinum* has spores  $87.1-117.3 \times 3.5-4.5 \mu$ , 2-septate, cylindrical, falcate at one end in most cases, produced in small, compact, barrel-shaped masses which may become confluent for several mm.

The more irregular shape of the spores in *C. smilacinae* may be attributed to their method of production in large, irregular masses which on macroscopic examination of the leaf surface appear as whitish areas in the blackened infected areas of the leaf. The small, barrel-shaped masses of conidia in *C. veratrinum* appear as pink spots on blackened infected areas.

The original description of *C. veratrinum*, quoted in Saccardo, Sylloge Fungorum, describes the spores as being  $70-90 \mu$  long. The material from Mt. Shasta noted above has longer spores, as does another collection observed recently. In July 1946, George Nyland obtained at Chinook Pass, Yakima Co., Washington, material assigned to this species by C. G. Shaw, on *Veratrum viride* Ait. (W.S.C. pl. p. 17446). The spores of this specimen measure up to  $170 \mu$  long although some spores fall within the range described by Saccardo and Winter.

This material again brings up the question of polymorphic species of leaf parasites of wild hosts. More extensive series of collections will be necessary to determine whether we are dealing here with only one species or with a group of closely related species.

8. *PHYLLOSTICTA MELANOPLACA* Thüm. Pycnidia assigned to this species by Lee Bonar were found associated with *Cylindro-*

*sporium veratrinum* on infected leaves of *Veratrum californicum* collected at Wagon Camp, Mt. Shasta. It has small, bacillar spores  $2.5-4 \times 1.0-1.5 \mu$ . There is no indication that it is associated with the life cycle of the *Cylindrosporium*.

9. *DOTHIORELLA MAGNIFRUCTA* (Pk.) Petrak & Sydow (*Phoma magnifructa* Peck). Material referred by Lee Bonar to this species was collected on April 8, 1947 by W. B. and V. G. Cooke, W. B. Cooke 19336, Mycobiota of North America 276, on cones of *Libocedrus decurrens* Torr. lying on the ground along the Mud Creek Dam road a mile north of McCloud on the south side of Mt. Shasta.

This species forms small stromata in which 5-20 pycnidia are embedded. The pycnidiospores are cylindric, hyaline, non-septate,  $18-22 \times 3.2-3.8 \mu$ .

10. *SELENOPHOMA LINICOLA* T. C. Vanterpool. Pycnidia on the surface of stems the summer following the death of the above-ground portions of the host. Spores luniate, hyaline, non-septate,  $16-22 \times 2.9-3.5 \mu$ .

On dead stems of *Iliamna bakeri* (Jeps.) Wiggins in the chaparral along the Shasta Snowline Highway, 4500 ft., Mt. Shasta, July 12, 1946, W. B. Cooke 18233.

Morphologically this material is too close to *S. linicola* to establish it as a distinct species, although reference to collections of material published in the literature gives a precedent for such treatment. Cross-inoculation studies have not been made on it and it does not appear to be pathogenic since it was found on year-old litter.

11. *SEPTORIA LUNELLIANA* Sacc. Several plants of *Carex fraxa* Mkze. at MacBride Springs Public Camp, 5000 ft., Mt. Shasta, were found to be heavily infected with this species on July 3, 1947, W. B. Cooke 20226. The spots are white, surrounded by brown discolored areas which become confluent for large areas on the leaf. Pycnidia are scattered in the spots. The spores are 3-septate, hyaline,  $55-77 \times 3-3.5 \mu$ . This specimen was identified by Roderrick Sprague and distributed as no. 278 in Mycobiota of North America.

12. *SEPTORIA AROMATICA* Kabat & Bubak. Lesions at first yel-

low, then blackened with areas in which black pycnidia are located. These areas are not usually confluent and the pycnidia are scattered in them, but whole leaf segments may appear to become blackened. Pycnidia black, 75–100–150  $\mu$  in diameter. Spores straight to curved, 1–3-septate, 63.5–80.4  $\times$  3.5–4  $\mu$ , hyaline.

On *Ligusticum grayi* C. & R. along Panther Creek below the meadows, 7000 ft., Mt. Shasta, Aug. 15, 1947, W. B. Cooke 20441.

No species of *Septoria* were found listed on *Ligusticum grayi* nor on related species from Western North America and a check was made on those species reported in Saccardo on umbelliferous hosts. From the sixty-four names found, seven species fall into or near the spore-size range noted above. The description of the species to which this collection is assigned fits this collection better than any of the other six.

13. *Phyllosticta crustosa* Lee Bonar & W. B. Cooke, sp. nov. Maculis hypophyllis, atris, confluentibus et totum folium saepe occupantibus; hyphis atris, in epidermide crustosis; pycnidiis globosis, sparsis vel gregariis, subepidermalibus, 90–130  $\mu$  diam., pallide brunneis; ostiolo non papillato, poroideo; pycnidiosporulis bacillaribus, unicellularibus, hyalinis, 5.7  $\times$  0.5–0.7–1  $\mu$ ; conidiophoris simplicibus, hyalinis, 8–13  $\mu$  longis.

Hab. in foliis vivis *Kelloggiae galioidis*, 1850 m., Sisson Southern Trail, Mt. Shasta, Siskiyou Co., Calif., Aug. 22, 1947. W. B. Cooke 20471.

Hypophyllous as blackish spots on leaves, distinct specks becoming confluent and often covering the entire leaf; blackening due to closely packed, sinuous dark hyphae in epidermal cells which form a black crust; pycnidia scattered, subepidermal, arising beneath the crust, light brown in color; ostiole poroid, non-papillate, conidia bacilliform, 1-celled, hyaline, 5–7  $\times$  0.5–0.7–1  $\mu$ ; conidiophores simple, hyaline, 8–13  $\mu$  long.

**Type** collected on leaves of *Kelloggiae galioides* Torr., W. B. Cooke 20471, Sisson Southern Trail, Mt. Shasta, Siskiyou Co., Calif., Aug. 22, 1947. A second collection is filed at the Herbarium of the University of California: Rock Creek, 1.6 miles S.E. of Dean's Valley, S.E. of Meadow Valley, Plumas Co., Calif., Aug. 11, 1947. C. R. Quick 47–109.

The fact that *Kelloggiae* leaves were infected with some sort of disease was noted during the several years that the writer hiked Mount Shasta trails. However, after several futile attempts, fruiting material of the fungus was collected only in 1947.

Records of fungi on *Kelloggia* are not frequent and no record of a fungus such as this has been found in the literature. The writer is indebted to Lee Bonar for the above English description.

In 1889 Ellis and Everhart described *Hainesia borealis* from material of diseased *Galium boreale* L. collected at Kamloops, British Columbia, by J. Macoun. Material of this species was collected by R. Sprague, G. W. Fischer and J. P. Meiners on *Galium boreale* below Teton Pass in Teton Co., Wyoming near the Idaho line on Aug. 13, 1948. This material is housed in the Herbarium of the Dept. of Plant Pathology, State College of Washington as No. 17452. The disease symptoms of this specimen look very much like those on young specimens of the Mount Shasta material but the spores are produced in acervuli rather than in pycnidia.

Such a situation was noted by C. L. Shear and B. O. Dodge in *Pezizella lythri* (Desm.) Shear & Dodge. In a paper entitled "The life history and identity of '*Patinella fragariae*,' '*Leptothyrium macrothecium*,' and '*Peziza oenotherae*'" (*Mycologia* 13: 135-170, 1921), they recognized under *Pezizella lythri* two types of imperfect stages. The first of these was *Hainesia lythri* (Desm.) v. Höhn. It represented the conidial stage, and thirteen synonyms were listed for it. The second of these, the pycnidial stage, was *Sclerotiopsis concava* (Desm.) Shear & Dodge under which twelve earlier names were placed in synonymy. It is possible that *Hainesia borealis* Ell. & Ev., which has spores borne in acervuli and measuring  $5-7 \times 0.5-1 \mu$ , and *Phyllosticta crustosa* Bonar & W. B. Cooke, which has spores borne in pycnidia and measuring  $5-7 \times 0.5-1 \mu$ , are similarly two types of imperfect stage of an as yet unidentified or unknown ascomycetous fungus.

14. *Hysterium acuminatum* Fr. var. *alpinum* Rehm. Rehm referred material collected on *Pinus cembra* in the Tyrol to this variety in his *Ascomycetes* No. 125. Three collections from Mount Shasta have been referred to this category by the writer and by Lee Bonar. They agree well with the description given in Saccardo (*Syll. Fung.* 2: 746. 1883). This species has been collected on bark of *Tsuga mertensiana* (Bong.) Sarg., W. B. Cooke 8663, Aug. 24, 1937, at Panther Creek; on wood of *Abies magnifica* var. *shastensis* Lemmon, W. B. Cooke 10148, June 23, 1938, at

Horse Camp; and on boards of *Pinus ponderosa* Dougl. at Horse Camp, 8000 ft., W. B. Cooke 18228, 18274, July 1946.

The hysterothecia are 0.5–0.8 mm. long, dull black, superficial, filled with asci in all stages of development,  $105\text{--}120 \times 7\text{--}8\ \mu$ ; the spores are brown, smooth, uniseriate, constricted at the middle septum,  $13\text{--}15 \times 6\ \mu$ . The spores are at first hyaline, develop a central septum before pigmentation starts, have most of their pigmentation before the second and third septa develop, and are finally dark-brown and 4-celled.

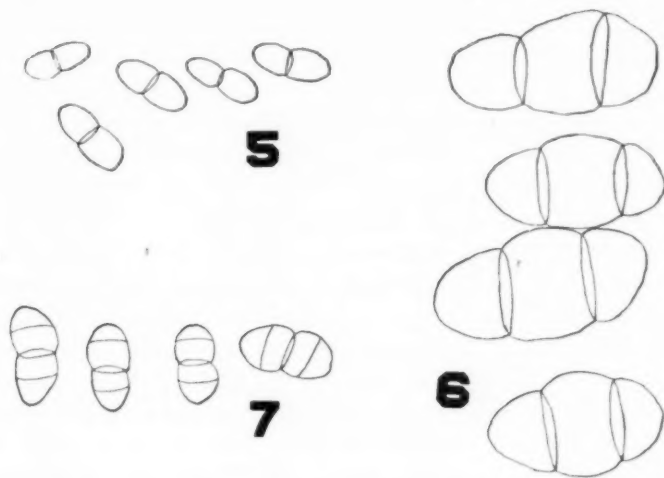


FIG. 5. Spores of *Dimerium alpinum*. FIG. 6. Spores of *Exosporium pedunculatum*. FIG. 7. Spores of *Hysterium acuminatum* var. *alpinum*.

15. *Dimerium alpinum* W. B. Cooke, sp. nov. Mycelio amphigeno, atro-brunneo, ex hyphis repentibus, ramosis,  $3.5\text{--}10.8\ \mu$  diam.; peritheciis ovoideis, membranaceis, non papillatis, levibus, atris; ascis cylindraceutis,  $43.5\text{--}58 \times 8.7\text{--}10.2\ \mu$ , aparaphysatis, octosporis; ascosporis uniseriatis vel biseriatis, ellipsoideis, 1-septatis, medio constrictis, brunneis,  $11.6\text{--}13.2 \times 4.35\text{--}5.8\ \mu$ .

Hab. ad folia *Pentstemonis menziesii* var. *dauidsonii*, 3000 m., Mt. Shasta, Siskiyou Co., Calif., Jul. 30, 1946. W. B. Cooke 18314.

Perithecia black, without beak, in a dense mycelial mat,  $200\text{--}250\ \mu$  in diameter; hyphae of subiculum black, with thick cuticle,  $3.5\text{--}10.8\ \mu$  in diameter, loosely interwoven, well branched, septate, opaque, sometimes densely encrusted with foreign matter apparently caught in the gelatinous cuticle which is brown in color; asci  $43.5\text{--}$

$58 \times 8.7\text{--}10.2 \mu$ ; ascospores brown, 2-celled,  $4.35\text{--}5.8 \times 11.6\text{--}13.2 \mu$ , constricted at the septum, uniseriate to biseriate, thick-walled, lower cell slightly smaller than upper cell in some asci.

Forming black crusts usually on lower surface of leaves of *Pentstemon menziesii* var. *davidsonii* (Greene) Piper, sometimes blackening whole plants or portions of plants which grow mat-like in protection of rocks in the White Bark Pine and Alpine Zones, Mt. Shasta, Siskiyou Co., Calif. **Type collection**: W. B. Cooke 18314, July 30, 1946, 9000 ft., Mt. Shasta. Other collections from the southwest side of Mt. Shasta between 9000 and 10,000 feet in the White Bark Pine and Alpine Zones include W. B. Cooke numbers 8601, July 28, 1937; 10252, July 28, 1939; 15711, Aug. 14, 1941; and 20479, Aug. 28, 1947.

Collections of material of this species made prior to 1946 and in 1947 were mostly immature. The 1946 collection showed mature ascus and spore characters well. If it seems peculiar that a sooty mold should grow at such high altitudes, it should be remembered that moisture and relative humidity are very high under the snow pack which covers the higher slopes of the mountain for more than six months of normal years. Temperature conditions under the snow pack are not well known but are such that some fungus growth is permitted during the existence of the pack. The moisture and humidity conditions are high enough to satisfy the requirements of large numbers of "micromycetes," most important of which are the brown felt or smothering fungi, *Neopeckia coulteri* on pines and *Herpotrichia nigra* on firs and hemlock.

16. *Cryptosporella acerina* L. E. Wehmeyer, sp. nov. Stomatibus sub cortice nidulantibus discoideis idque pustulatim elevatibus, discis densis, atris, rotundis vel ellipticis erumpentibus; peritheciis 5-10, in cortice immersis, globosis vel elongatis, atro-brunneis,  $300\text{--}400 \times 200\text{--}350 \mu$  diam.; ostiolis elongatis,  $100\text{--}200 \mu$  diam., in discum per peridermium erumpentibus; ascis numerosis, clavatis, basibus deciduis, tenuibus,  $45\text{--}70 \times 12\text{--}14 \mu$ , octosporis; ascosporis biseriatis, unicellularibus, hyalinis vel late fusoides,  $10\text{--}12.5 \times 4.5\text{--}5 \mu$ .

Hab. in cortice ramulorum emortuorum *Aceris glabri*, 2000 m., Mt. Shasta, Siskiyou Co., Calif., Aug. 8, 1947. W. B. Cooke 20413.

On surface as longitudinally seriate, crowded, rounded or elliptic, black, wrinkled or rugose discs which are erumpent through longitudinal ruptures of the periderm. These discs have a tough, rubbery texture, the edges are emarginate, raised, curled inward or

wrinkled. The discs may or may not contain several short-cylindric, punctate ostioles. The disc originates just beneath the periderm as a parenchymatic mass of dark brown, thick-walled, coarse-celled ectostroma which ruptures the periderm. The perithecia, which are formed in clusters of 5–10 beneath the discs, in the bark cortex, are  $300\text{--}400 \times 200\text{--}350 \mu$  in diameter, globose or radially elongate from crowding, and have stout ostiolar necks,  $100\text{--}200 \mu$  in diameter, which penetrate the overlying ectostroma. The walls of the perithecia and ostioles are  $15\text{--}30 \mu$  thick and consist of an outer layer of coarse, dark brown, compressed parenchyma cells and a thin layer of light-colored finer hyphae. Asci numerous, clavate, soon deciduous at the base and free in the perithecium, thin-walled with a refractive ring in the apex,  $45\text{--}70 \times 12\text{--}14 \mu$ . Spores biseriata, one-celled, hyaline, ellipsoid to broad fusoid,  $10\text{--}12.5 \times 4.5\text{--}5 \mu$ .

**Type collection:** on *Acer glabrum* Torr., Sisson Southern Trail Spring, 6000 ft., Mt. Shasta, Aug. 8, 1947, W. B. Cooke 20413.

This species differs from all other described species of *Cryptosporella* in the large black erumpent discs and in the smaller spores. There are evidences of cavities in the upper portions of the ectostroma, in which conidia may have been formed in the early development of this tissue.

The writer is indebted to L. E. Wehmeyer for studying this and the following species, for preparing the English diagnoses and the notes and the accompanying illustrations of these two species.

17. **Massarinula lignorum** L. E. Wehmeyer, sp. nov. Peritheciis parenchymaticis, crassis, atris, laxe gregariis, in ligno immersis,  $600\text{--}1000 \times 300\text{--}500 \mu$ ; ostiolo minuto, papillato; ascis late-clavatis,  $105\text{--}125 \times 20\text{--}25 \mu$ ; paraphysibus numerosis, filiformibus, persistentibus; ascosporis biserialis, hyalinis, fusoido-ellipsoideis, plus minusve inaequilateralibus vel curvatis, 1-septatis, 4-guttulatis, medio-constrictis,  $35\text{--}44 \times 10\text{--}12 \mu$ , apicibus contractis, plus minusve obtuse rotundatis.

Hab. in ramulis emortuis *Accris glabri*, 2000 m., Mt. Shasta, Siskiyou Co., Calif., Aug. 8, 1947. W. B. Cooke 20403.

On surface as rather thickly scattered, circular to elliptic, black pustules with a minute, papillate, central ostiole. Perithecia flattened ellipsoid,  $600\text{--}1000 \times 300\text{--}500 \mu$ , buried in the surface layers of the wood and erumpent through the ruptured overlying fibers. Perithecial walls of very coarse, black-walled parenchyma, thin ( $20\text{--}30 \mu$ ) below, much thicker ( $50\text{--}100 \mu$ ) on the upper exposed surface. Asci broadly clavate, wall somewhat thickened above,  $105\text{--}125 \times 20\text{--}25 \mu$ , imbedded in a mass of filiform, hyaline, per-

sistent paraphyses. Spores biseriate, hyaline, fusoid-ellipsoid, somewhat inaequilateral or curved, two-celled but 4-guttulate, possibly becoming 4-celled at full maturity, constricted at the central septum, ends tapered and somewhat bluntly rounded,  $35-44 \times 10-12 \mu$ .

**Type collection:** on *Acer glabrum* Torr., near Sisson Southern Trail Spring, 6000 ft., Mt. Shasta, Aug. 8, 1947, W. B. Cooke 20403.

There exists a large group of species, all of which are very similar in spore form and perithecial structure and to which the species just described belongs. They have fusoid, hyaline, spores with a characteristic "biconic" form, strongly constricted at the middle, swollen on both sides of this septum and tapered toward the ends, usually inaequilateral or curved. These spores are usually 2-celled at first then 4-guttulate and then 4-celled. In some cases they may turn brown at extreme maturity. They may or may not have a gelatinous envelope, which in the writer's opinion is unimportant but it is used as a diagnostic character of the Massariaceae. The color and septation of the spores vary with maturity and with the species, but it is often difficult to distinguish between these two factors because of overlapping types. As a result, these fungi, though closely related, are to be found in a number of genera. They are related on the one hand to certain species of *Didymella* and the genus *Massarinula* in the Massariaceae and on the other hand to certain species of the genus *Metasphaeria* and *Massarina*.

The perithecia have a structure similar to that common in the Massariaceae, with numerous persistent paraphyses. The fungus here described is very similar to *Massarina eburnioides* Sacc., *M. pomacearum* Höhn. and *M. corni* (Fekl.) Sacc. Höhnelt (Ann. Myc. 15: 361. 1917) has already noted the similarity of these species and their relation to *Metasphaeria*, when the gelatinous envelope about the spore is lacking. *Massarinula lignorum* has the same large spores, but these have no gelatinous envelope and they remain, for the most part, two-celled. Although they possess four large guttulae, and a few cases were seen in mounts in Amann's solution where the spore protoplast seemed to be four-parted, most spores were definitely two-celled as seen in this medium.



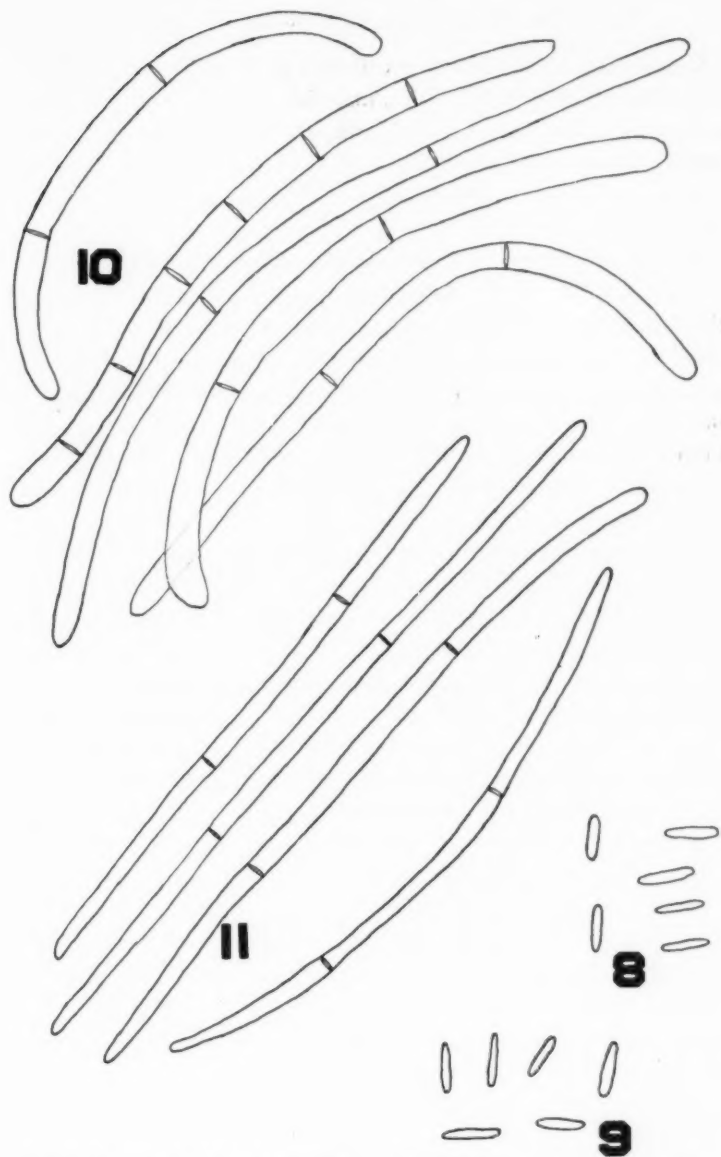


FIG. 8. Spores of *Phyllosticta crustosa*. FIG. 9. Spores of *Hainesia borealis*.  
FIG. 10. Spores of *Cylindrosporium veratrinum*. FIG. 11. Spores of *Cylindrosporium smilacinae*.

## B. SOME SPECIES ASSOCIATED WITH SAMBUCUS

On July 25, 1946, the writer collected at Bear Springs, 5000 ft., Mt. Shasta, Siskiyou Co., Calif., material identified by comparison with material distributed from Northport, Washington, by Science Service, Ottawa, as *Exosporium sambuci* Tracy & Earle. The Mt. Shasta specimen was distributed as no. 208 in the "Mycobiota of North America."

Recently in checking over material in that part of the C. V. Piper collections housed in the Herbarium of the Botany Department of the State College of Washington, specimens were found of *Brachysporium puccinioides* E. & E. and *Brachysporium pedunculatum* Ell. & Ev. from Pullman, Washington. These specimens compared favorably with the material from Mt. Shasta, Northport, and a more recent collection from the top of the White Bird Grade, 4400 ft., Idaho Mountain, Idaho Co., Idaho, W. B. Cooke 23807, June 12, 1948.

In order to clarify the status of these specimens material of *Exosporium* and *Brachysporium* species on *Sambucus* species was kindly loaned by B. B. Kanouse, University of Michigan; H. M. Fitzpatrick, Cornell University; D. P. Rogers, New York Botanical Garden; J. A. Stevenson, Mycological Collections, Beltsville, and G. W. Martin, State University of Iowa. In addition to specimens of these species, material of *Heterosporium* and *Helminthosporium* was obtained. It was thought that since *Brachysporium* had been confused with *Exosporium* it was possible that some collections filed under these genera might belong to this complex.

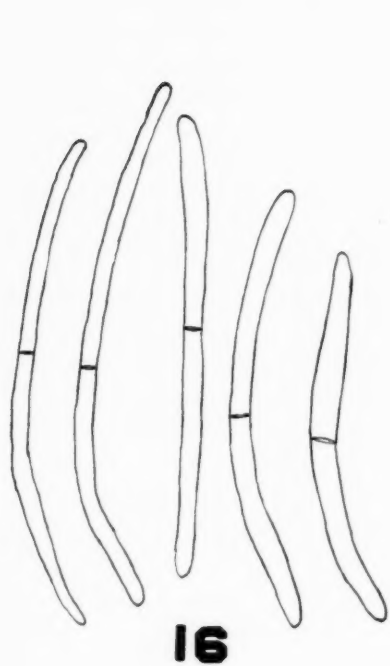
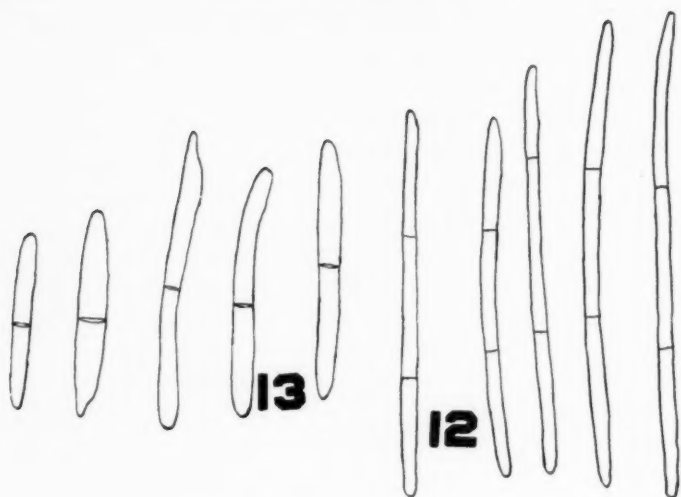
*Exosporium* was first described by Link (Mag. Ges. Naturf. Fr. Berlin 3: 9. 1809). It was used again by Link in 1825 in Vol. 6, part 2, of Willdenow's 4th edition of Linnaeus' Species Plantarum. Fries reduced the species of *Exosporium* to synonymy in *Helminthosporium* since he considered these species as only stromatic members of this genus. If it is noted below how later workers have confused *Brachysporium*, a segregate of *Helminthosporium*, with *Exosporium*, one can see how Fries could have placed *Exosporium* in *Helminthosporium*.

In 1869, Fuckel (Symb. Myc. p. 372) applied the name *Cryptocoryneum* to fungi of this type. Lindau, in Rabenhorst's Krypto-

gamen Flora, ed. 2, Vol. 9, p. 362, 1910, used *Exosporium* and indicated that this was in accord with von Höhnelt's treatment. In 1923, von Höhnelt accepted both genera and added *Phanerocorynecium* to the group. He distinguished them by assigning to *Exosporium* erumpent, cartilaginous species, to *Phanerocorynecium* species which were superficial, with longish, loosely arranged conidia, and to *Cryptocorynecium* superficial species with long, cylindric, many-celled conidia which occur in dense bundles. Clements and Shear, Genera of Fungi, 1931, indicate that the difference between *Cryptocorynecium* and *Exosporium* is that in the former the sporodochia are superficial, in the latter they are erumpent.

*EXOSPORIUM SAMBUCI* Tracy & Earle. In 1898 Tracy and Earle distributed as No. 1104 in their "Plants of Colorado" under this name a fungus collected on *Sambucus melanocarpa* along the La Plata River at 10,000 feet, Durango Co., Colorado, by C. F. Baker, F. S. Earle and S. M. Tracy. In this material the sporodochia are visible as black elliptical spots under splits in the bark which may have originated at the lenticels. The sporodochia develop on or below the cambium. The lesions are  $0.5-3 \times 0.1-0.5$  mm. They may eventually become confluent although this is not particularly evident in the two specimens of the type collection from the New York Botanical Garden. The large size is attributed to the large sporodochium rather than to the confluence of more than one sporodochium. The sporophores are densely packed together,  $5-6 \mu$  in diameter, septate, yellowish, and are often deciduous, remaining attached to the spores, even after rough treatment in making crush mounts. The conidia are ovate to obovate, yellow-brown, usually 3-septate (although 2-septate spores are seen in every mount), usually constricted at the septa, in spite of the fact that in the original description it is stated that they are not constricted, and measure  $40-44 \times 17-20 \mu$ .

*Brachysporium sphaerocolum* F. E. Clements, nom. nud. Material assigned to this species was collected by F. E. and E. S. Clements at 2500 m. (7500-8000 ft.) in Larkspur Dell, Colorado, on July 11, 1905. The specimen was obtained from *Sambucus microbotrya* in a *Picea-Pseudotsuga* Association. It was distributed in Clements' "Cryptogamae Formationum Coloradensium,"



in which it was not described, and was loaned to me by Mr. Stevenson. The label of this specimen merely contains habit and habitat information in Latin. Microscopic examination indicates that this specimen is *Exosporium sambuci* Tracy and Earle. Thus two specimens are on record of *Exosporium sambuci* and both are from Colorado.

**BRACHYSPORIUM PUCCINOIDES** Ell. & Ev. C. V. Piper collected material at Pullman, Whitman Co., Washington, W.S.C. 170463, which Ellis assigned to this species. However, according to a note on the type packet at the New York Botanical Garden, Ellis and Anderson already had assigned this name to a species of *Macrosporium*. Thus Ellis changed the name to *Brachysporium pedunculatum* Ell. & Ev. Piper's specimen was distributed to several herbaria before the correction was made. The earlier name is a *nomen nudum* and should be used only in synonymy with the following species:

***Exosporium pedunculatum*** (Ell. & Ev.) W. B. Cooke, comb. nov.

*Brachysporium pedunculatum* Ell. & Ev., Proc. Acad. Phil. 1895, p. 440. 1895.

*Brachysporium puccinioides* Ell. & Ev. in herb., *nomen nudum*.

This species is based on material collected by C. V. Piper on March 24, 1894, at Pullman, Whitman Co., Wash., on dead branches of *Sambucus glauca* Nutt. Piper's specimen, the type, was assigned the number 316, and duplicates have been observed from the New York Botanical Garden, Mycological Collections, and the Herbarium of the State College of Washington, 170463.

This species, too, has spores which are produced on sporodochia. These structures, in dry specimens, are hard, black, sclerotic masses. They appear, in microscopic examination, as rather large *Puccinia* pustules. (This accounts for the first name assigned the species by Ellis.) The sporodochium is produced on or under the cambium and breaks through the bark at lenticels, at weak points in the bark, or in elongate linear areas in the internodes. These sporo-

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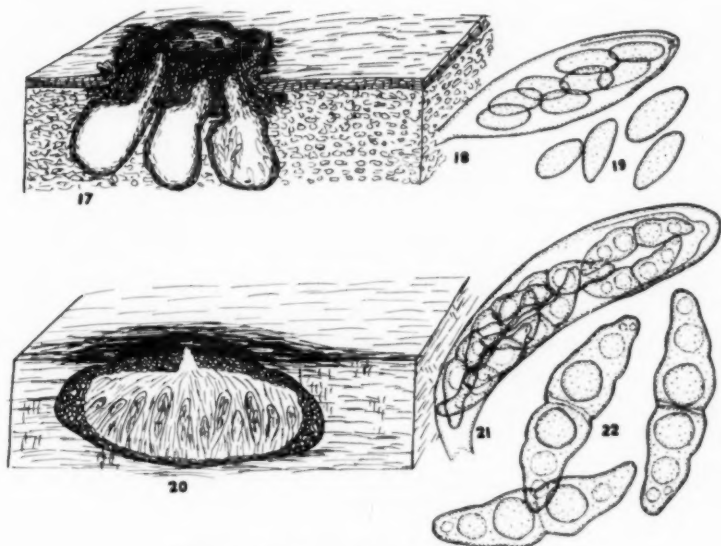
FIG. 12. Spores of *Septoria lunelliana*. FIG. 13. Spores of *Ramularia claytoniae*. FIG. 14. Spores of *Selenophoma linicola*. FIG. 15. Spores of *Ramularia pentstemonis*. FIG. 16. Spores of *Septoria aromatica*.

dochia may become confluent. Upon making fresh water-mounts the sporophores may become detached along with the spores, making them appear "pedunculate." The sporodochia in the Revelstoke collection measure 0.25–0.5 mm. in diameter. Confluence may increase this size to a half centimeter or more in length. The conidiophores are  $12\text{--}15 \times 6\text{--}7 \mu$ , septate, yellowish. The spores are produced terminally. The conidiospores are  $22\text{--}30 \times 12\text{--}15 \mu$  in the type collection,  $25\text{--}36 \times 14.5\text{--}18 \mu$  in the Revelstoke collection, and the other collections examined have spores of similar or intermediate dimensions. The spores are two-septate, brown to dark brown, usually constricted at the septa, with a swollen central cell which gives them a blunt fusiform to barrel shape. Some of the spores are flattened on one side and this, with the swollen central cell, gives the spore a "*Curvularia*" aspect. The original description, and Ellis' notes on the type packet at the New York Botanical Garden, indicate that Ellis did not notice the constrictions at the septa. All the spores observed were two-septate. In addition to the Pullman specimen, specimens have been examined from Revelstoke, 1500 ft., British Columbia, collected Sept. 25, 1930 by J. R. Hansbrough 158 (NYBG); Northport, Pend Oreille Co., Wash., Sept. 24, 1929, A. W. McCallum, distributed by Herbarium, Division of Botany, Ottawa, Canada (Myc. Coll., U. Mich., U. Calif.); Cedar Mt., Latah Co., Idaho, July 1898, C. V. Piper 691; Herb. St. Coll. Wash. 170295; Mt. Idaho, Idaho Co., Idaho (WBC); Mt. Shasta, Siskiyou Co., Calif. (WBC, Mycobiota of North America 208); and San Antonio Canyon near Claremont, Los Angeles Co., Calif. Pacific Slope Fungi, dist. by C. F. Baker, collected Oct. 10, 1903 by C. F. Baker (NYBG). All have the same microscopic features although there is some variation in size and degree of confluence of the sporodochia.

*Brachysporium* is a member of the Dematiaceae and thus is non-stromatic or moniliaceous in fruiting habit. Since *Exosporium* has sporodochia it is placed in the Tuberculariaceae. Since material of *Exosporium pedunculatum* Ell. & Ev. in all mounts shows spores produced on sporodochia it should be placed in the Tuberculariaceae rather than in the Dematiaceae. At present, *Exosporium* is the best genus in the Tuberculariaceae in which to place it. It differs from *Exosporium sambuci* Tracy & Earle, known so

far only from two Colorado collections, in its smaller, three-celled spores.

Link established the genus *Helminthosporium* in 1809. Persoon in 1822 used it in essentially the same sense. The concept of the genus or its description has become enlarged until today it is used in the sense of Lindau, Vol. 9, ed. 2, of Rabenhorst's *Kryptogamen Flora*. Dreschler (Graminicolous species of *Helmintho-*



FIGURES 17-22 drawn by L. E. Wehmeyer.

FIG. 17. Section through perithecial stroma of *Cryptosporrella acerina*. FIG. 18. Ascus of *Cryptosporrella acerina*. FIG. 19. Ascospores of *Cryptosporrella acerina*. FIG. 20. Section through perithecium of *Massarinula lignorum*. FIG. 21. Ascus of *Massarinula lignorum*. FIG. 22. Ascospores of *Massarinula lignorum*.

*sporium*, Jour. Agr. Res. 24: 641-739. 1923) indicates that *Brachysporium* Sacc. is merely a repository for short-spored species, and *Napicladium* Thüm. is only a repository for tapered-spored species, and that both are only variations of *Helminthosporium* which are not constant and for which various intergradations can be demonstrated. In both Drechsler's and Gilman's (Manual of Soil Fungi, Ames, 1944) treatments the concepts out-

lined by Lindau are followed. That is, the conidiophores are geniculate and produce multiseptate dark spores acrogenously or, more usually and in mature specimens, acropleurogenously. The conidiospores are smooth.

*Heterosporium* was used first by Klotzsch in Herb. mycol. n. 67 and 69, 1832, for a phragmosporous dematiaceous fungus with rough spores. It was also used in this sense by M. C. Cooke (Grev. II. 122. 1877). While it is not so indicated in Lindau's description, the illustrations in the accompanying specific descriptions show acropleurogenous, geniculate conidiophores so that this fungus is essentially a repository for species of fungi like *Helminthosporium* with roughened spores. Lindau indicates that *Heterosporium* Klotzsch ex Cooke is mostly parasitic while *Helminthosporium* is mostly saprobic. This is not a usable delimitation since a large number of species of *Helminthosporium* are parasitic.

*Dendryphiella* was erected by Bubak & Ranojevic (N. Ranojevic, Dritter Beitrag zur Pilzflora Serbiens, Ann. Myc. 12: 393-421. 1914) to accommodate species of phragmosporous dematiaceous fungi whose conidia are roughened and produced acropleurogenously on geniculate conidiophores. It was based on *Helminthosporium interseminatum* Berk. & Rav. Berkeley included the species in *Helminthosporium*. Probably he did not consider the roughness on the spores as sufficient for generic segregation. *Dendryphiella* is plainly a synonym of *Heterosporium*.

*HELMINTHOSPORIUM INTERSEMINATUM* Berk. & Rav. This species is occasionally found as a brown-black to purple-black fungus on dead herbaceous or woody stems. It is poorly represented in herbaria but specimens on *Sambucus* and *Phytolacca* have been examined and it has been reported on *Humulus* and *Anthriscus*. That it is widespread in eastern North America is indicated by the following locations from which material has been observed: Newfield, New Jersey (BPI, Cornell); Auburn, Lee Co., Alabama (Cornell); Tuskegee, Alabama (BPI); Lancaster, Fairfield Co., Ohio (BPI); Fayette Co., West Virginia (BPI); and near Iowa City, Iowa (St. Univ. of Iowa).

The felty area on the dead sticks may be sharply limited or have indefinite limits. It may be associated with other fungi but no relationship between these fungi and its life cycle is indicated. Upon



microscopic examination one finds an intricately interwoven mass of branched hyphae which stand erect from the substratum. No sterile hyphae were seen, nor are any described by other workers. The conidiophores may range from 100 to 500  $\mu$  long by 6 to 8  $\mu$  in diameter. They are simple or branched and when branched the branches become interwoven to form the observed felt. Near each septum may be produced 1-4 spores giving the conidiophores a nodulose or a geniculate appearance. Usually only one spore is produced but the scars of 2, 3, or 4 spore-production points are not infrequent. At the tip of the conidiophore spores also are produced so that the spores are produced acropleurogenously. The conidiophores are smooth to minutely roughened toward the tip.

The spores are usually four-celled although there may be four septa in some cases. They are roughened by fine verrucae. While the type description indicates that the spores are 20-22  $\mu$  long, in a collection by G. F. Atkinson at Auburn, Alabama, they are 21.8-25.2  $\times$  4-5  $\mu$ , a measurement characteristic of other specimens examined.

Earlier writers indicate that *Helminthosporium vimineum* B. & C. var.  $\gamma$  and *Dendryphium nodulosum* Sacc. are synonyms.

**HETEROSPORIUM SAMBUCI** Earle. Material assigned to this species by Earle was collected by L. M. Underwood (NYBG) on Mar. 13, 1896, at Auburn, Lee Co., Alabama. Its characters agree well with those of *Helminthosporium interseminatum* and it was placed in synonymy with that species by Atkinson.

*Dendryphiella interseminatum* (Berk. & Rav.) Bub. & Ran. As indicated above this combination was made to accommodate this rough-spored species of *Helminthosporium* with geniculate conidiophores on which the spores are produced acropleurogenously. Since these conditions are all met by *Heterosporium*, this binomial should be placed in synonymy with the following.

**HETEROSPORIUM INTERSEMINATUM** (Berk. & Rav.) Atk.

*Helminthosporium vimineum* B. & C. var.  $\gamma$

*Helminthosporium interseminatum* Berk. & Rav.

*Dendryphium nodulosum* Sacc.

*Heterosporium sambuci* Earle

*Heterosporium interseminatum* (Berk. & Rav.) Atk.

*Dendryphiella interseminata* (Berk. & Rav.) Bub. & Ran.

This combination was made in "Some fungi from Alabama," Bull. Cornell Univ. (Science) 3(1): 1-50. June, 1897. Material on which this combination was based is housed at Cornell University and was collected in 1891 at Auburn, Lee Co., Alabama.

The writer wishes to acknowledge the assistance of Lee Bonar, Dept. of Botany, University of California, and L. E. Wehmeyer, Dept. of Botany, University of Michigan, in identifying the specimens described above; Donald P. Rogers, New York Botanical Garden, for checking the Latin diagnoses and reading the manuscript; the several people listed above for the loan of specimens; and C. G. Shaw, State College of Washington, for checking the manuscript.

BOTANY DEPT.,  
STATE COLLEGE OF WASHINGTON,  
PULLMAN, WASHINGTON

## STUDIES ON ROCKY MOUNTAIN FUNGI—I<sup>1</sup>

W. G. SOLHEIM<sup>2</sup>

This paper is the first in a proposed series in which the author plans to publish descriptions of new species and notes on other fungi of special interest. In 1934 the author started issuing a set of fungi entitled "Mycoflora Saximontanensis Exsiccata." Publications covering these issues have appeared in the "University of Wyoming Publications." In these several new species have been described. Through this new series wider circulation will be had for the descriptions of the new species.

In this paper nine species are described as new. All of these will be included in the fifth century of the exsiccata. The present distribution of the set is: Rocky Mountain Herbarium of the University of Wyoming, Farlow Herbarium of Harvard University, Arthur Herbarium of Purdue University, Herbarium of the New York Botanical Garden, Herbarium of the Bureau of Plant Industry, Herbarium of the Department of Plant Pathology of Cornell University, Herbaria of the Universities of California, Colorado, Illinois, Michigan, Tennessee, Wisconsin, Herbarium of Ohio State University, Cryptogamic Herbarium of the University of Toronto, Herbarium of Dr. F. Petrak, Herbarium of the Directorate of Plant Protection, Quarantines and Storage of India, and the author's private herbarium. A set was sent to the late Dr. H. Sydow but this was no doubt destroyed.

### ***Anthostomella ratibidae* sp. nov.**

Maculis amphigenis, elongatis, usque ad  $25 \times 1$  mm., nigris: peritheciis innatis, dispersis, globosis, brunneo-nigris,  $175-300 \mu$ , per epidermidem nigrifactam obtectis, epidermide in papillas elevata; ostiolo fere plano,  $20-36 \mu$ : ascis 8-sporis, cylindricis,  $87-104 \times 12.2-15.8 \mu$ : sporidiis monostichis, oblongo-ellipsoideis,  $12.2-16 \times 7.5-8.7 \mu$ , olivaceis, 1-2-guttulatis: paraphysatis.

<sup>1</sup> Contribution from the Department of Botany and the Rocky Mountain Herbarium of the University of Wyoming No. 215.

<sup>2</sup> The author gratefully acknowledges the assistance of a Grant-in-Aid from the Sigma Xi Research Fund.

Specimen typicum in foliis et caulibus *Ratibidae tagetis* (James) Barnhart (Compositae), Cienega Canyon Recreational Area, Sandia Mountains, Albuquerque, Bernalillo County, New Mexico, Amer. Bor., 24 Octobri, 1948, legerunt W. G. & Ragnhild Solheim, sub numero 2323.

Spots amphigenous, elongate, up to  $25 \times 1$  mm., black: perithecia innate, scattered, globose, brownish-black,  $175\text{--}300\ \mu$ , covered by the blackened epidermis which is papillately raised over the perithecia; ostiole almost plane,  $20\text{--}36\ \mu$ : asci 8-spored, cylindrical,  $87\text{--}104 \times 12.2\text{--}15.8\ \mu$ : spores uniseriate, oblong-elliptical,  $12.2\text{--}16 \times 7.5\text{--}8.7\ \mu$ , olivaceous, 1-2-guttulate: paraphysate.

On leaves and stems of *Ratibida tagetes* (James) Barnhart, Cienega Canyon Recreational Area, Sandia Mountains, Albuquerque, Bernalillo County, New Mexico, Oct. 24, 1948, W. G. & Ragnhild Solheim No. 2323 (*type*) (Myc. Sax. Exs. No. 428).

Mature asci are rather rare in this specimen. The ascospores which are first hyaline and then olivaceous may possibly be much darker in more mature specimens.

***Lophionema apoclastospora* sp. nov.**

Peritheciis dispersis vel subgregariis, leniter immersis, nigris,  $500\text{--}1000\ \mu$  altis, ad basem depresso-sphaeroideis,  $145\text{--}506\ \mu$  latis, superna parte prominente, fortiter in latera compressa,  $115\text{--}318\ \mu$  latis, parte basali subinde circumdata mycelio brunneo et araneoso excrescente: mycelio regulari, atrobrunneo; hyphis  $3\text{--}4\ \mu$  crassis, saepe fila parallelum vel intertexturum hypharum formante: paraphysibus numerosis, hyalinis, filiformibus, circa  $1.2\ \mu$  crassis: ascis 8-sporis, anguste cylindrico-clavatis, ad basem aliquantulum attenuatis, aliquantulum flexuosis,  $390\text{--}540 \times 8.7\text{--}12.1\ \mu$ : sporidiis cylindræis, utrimque rotundatis, multiseptatis, aliquando constrictis, olivaceobrunneis,  $300\text{--}470 \times 2.3\text{--}3\ \mu$ , in segmenta derumpentibus; segmentis  $7\text{--}31.3\ \mu$  longis, continuis vel 1-4-septatis.

Specimen typicum in caulibus emortuis et decorticatis *Salicis* sp. (Salicaceae), Libby Creek prope castra viae, Medicine Bow Mountains, Albany County, Wyoming, Amer. bor., 27 Junii, 1942, legit W. G. Solheim, sub numero 2025.

Perithecia scattered or subgregarious, slightly immersed, black,  $500\text{--}1000\ \mu$  high, basal portion depressed spherical,  $145\text{--}506\ \mu$  wide, upper portion prominent, strongly compressed laterally,  $115\text{--}318\ \mu$  wide, basal portion at times surrounded by brown, cobwebby, mycelial outgrowths: mycelium regular, dark brown; hyphae  $3\text{--}4\ \mu$  diam., cells several times longer than broad, septa indistinct, frequently forming strands of parallel or interwoven hyphae: paraphyses numerous, hyaline, filiform, about  $1.2\ \mu$  diam.: asci narrowly cylindrical-clavate, attenuated toward the base, somewhat flexu-

ous,  $390-540 \times 8.7-12.1 \mu$ : spores cylindrical, ends rounded, multi-septate, constricted at fairly regular intervals, olive-brown, extending throughout most of the length of the ascus,  $300-470 \times 2.3-3 \mu$ , breaking up at points of constriction into segments; segments  $7-31.3 \mu$  long, continuous or 1-4-septate.

On dead, decorticated stems of *Salix* sp., near road camp on Libby Creek, Medicine Bow Mountains, Albany County, Wyoming, June 27, 1942, W. G. Solheim No. 2025 (*type*) (Myc. Sax. Exs. No. 430).

Only five species of *Lophionema* have previously been described. A comparison of these and the new species is given in table 1.

TABLE 1  
COMPARISON OF THE SPECIES OF *Lophionema*

Species	Perithecia	Asci	Spores	Segments
<i>vermisporum</i> (Ell.) Sacc.	150-200	$150-200 \times 12-15$	$75-88 \times 3.5-5$	
<i>implexum</i> Ell. & Ev.	about $1/3$ mm.	$150-160 \times 8-10$	subequal to asci	
<i>bambusae</i> v. Höhn.	0.5-1 mm. wide, $500-700 \mu$ high	to $300 \times 10$	$300 \times 1.8$	6-10
<i>chodati</i> Lendner	150 high $\times$ 450 wide	$90 \times 12-15$	80	6-7
<i>cylindrosporum</i> Kauffman	about 200	about $85 \times 17-20$	$60-65 \times 4-5$	
<i>apoclastospora</i> Solh.	500-1000 high, 145-506 wide at base, 115- 318 wide at top	$390-540 \times 8.7-12$	$300-470 \times 2.3-3$	7-31

***Phyllosticta alpinicola* sp. nov.**

Maculis indefinitis, superficie superna foliarum brunnescente vel nigro-brunnescente in partibus indefinitis vel toto folio decoloratis, superficie inferiore folii simili sed nigriore, ut videtur, propter copiam pycnidiarum et structurarum similium paratheciis: mycelio subhyalino vel flavo; hyphis tenuibus,  $1-3 \mu$ : pycnidiiis hypophyllis, dispersis, numerosis, globosis, in lineamento circularibus vel in latera compressis vel irregularibus, pallido-brunneis,  $66-132 \mu$ ; ostiolo plano vel leniter papillato,  $24-45 \mu$ : conidiis bacilliformibus, rectis vel leniter curvatis, hyalinis,  $4-7 \times 0.9-1.2 \mu$ .

Specimen typicum in foliis vivis *Trifolii parryi* Gray (Leguminosae), latere viae infra Brooklyn Lake, Medicine Bow Mountains, Albany County,

Wyoming, Amer. bor., 16 Augusti, 1930, legit W. G. Solheim, sub numero 50.

Spots indefinite, the upper leaf surface becoming brown to blackish-brown in indefinite sectors or the whole leaflet frequently discolored, lower leaf surface similar but appearing blacker due to the abundance of pycnidia and perithecial-like structures: mycelium subhyaline to yellowish; hyphae fine, 1-3  $\mu$ ; pycnidia hypophyllous, scattered, numerous, globose, in outline circular to laterally compressed to irregular, light brown, 66-132  $\mu$ ; ostiole plane or slightly papillate, 24-45  $\mu$ ; conidia bacilliform, straight or slightly curved, 4-7  $\times$  0.9-1.2  $\mu$ .

On living leaves of *Trifolium parryi* Gray, roadside below Brooklyn Lake, Medicine Bow Mountains, Albany County, Wyoming, Aug. 16, 1930, W. G. Solheim No. 50 (*type*) (Myc. Sax. Exs. No. 454).

Associated with this fungus are few to many, immature, blackish-brown, perithecial-like bodies.

This species differs from *P. bonansiana* Sacc. in having smaller conidia. Saccardo (Syll. Fung. 25: 49) gives the dimensions of the conidia as 7  $\times$  2.5  $\mu$ . *P. trifolii* Rich. (Syll. Fung. 10: 128) has ovoid conidia 2-3  $\mu$  long. *P. medicaginis* (Fckl.) Sacc. has spores 5-10  $\times$  1.5-2  $\mu$  as represented in a pure culture specimen made by Dr. Lee Bonar, University of California Herbarium No. 568035. Grove (Brit. Stem- and Leaf-Fungi 2: 140. 1937) has this species as a synonym of *Sporonema phacidioides* Desm. and gives the dimensions of the conidia as 5-7  $\times$  1.5-2  $\mu$ . The measurements for *P. trifolii-minoris* Unam. (Bol. R. Soc. Espan. Hist. Nat. 29: 120-121. 1929) are: pycnidia 75.5-83.5  $\times$  66.5-73.5  $\mu$ , conidia 5-7  $\times$  2.5-3.5  $\mu$ . *P. ignatiana* Unam. (Mem. R. Soc. Espan. Hist. Nat. 15: 348. 1929) is described as having pycnidia 130  $\times$  140  $\mu$  and conidia 6.5-7  $\times$  3  $\mu$ .

#### **Phyllosticta ragnhildae** sp. nov.

Maculis amphigenis, subcircularibus, ellipticis vel elongatis, 2-14  $\times$  2-5 mm., aliquando nervulis maioribus limitatis, atrobrunneis vel nigris, margine indefinita, folii textura cingente flavescens: mycelio hyalino; hyphis 2-3.5  $\mu$ ; pycnidiis amphigenis, dispersis, globosis, aliquando in latera compressis, 87-146  $\times$  76-111  $\mu$ , pallido-brunneis; ostiolo plano, 20-42  $\mu$ ; conidiis bacilliformibus, rectis vel curvatis, hyalinis, 3.5-5.2  $\times$  1  $\mu$ .

Specimen typicum in foliis vivis *Antennariae pulcherrimae* (Hook.) Greene (Compositae), Happy Jack Picnic Area, Laramie Mountains, Albany

County, Wyoming, Amer. bor., 6 Augusti, 1942, legerunt W. G. & Ragnhild Solheim, sub numero 2093.

Spots amphigenous, subcircular, elliptical to elongate,  $2-14 \times 2-5$  mm., at times limited by the larger veins, dark brown to black, border indefinite, surrounding leaf tissue becoming yellow: mycelium hyaline; hyphae  $2-3.5 \mu$ : pycnidia amphigenous, scattered, globose, at times laterally compressed,  $87-146 \times 76-111 \mu$ , light brown; ostiole plane,  $20-42 \mu$ : conidia bacilliform, straight or curved, hyaline,  $3.5-5.2 \times 1 \mu$ .

On living leaves of *Antennaria pulcherrima* (Hook.) Greene, Happy Jack Picnic Area, Laramie Mountains, Albany County, Wyoming, Aug. 6, 1942, W. G. & Ragnhild Solheim No. 2093 (*type*) (Myc. Sax. Exs. No. 462).

*P. antennariae* Ell. & Ev. has conidia  $7 \times 3 \mu$ . Associated with this specimen are immature fruiting bodies, probably young perithecia. It is possible that the new species is the spermagonial stage of some ascomycete.

#### **Phyllosticta smilacinae** sp. nov.

Maculis amphigenis, elongatis, in maximam partem nervulis maioribus limitatis, 1-5.5 cm. longis, 3-7 mm. latis, pallido-brunneis, brunneis vel brunneo-albis, aliquando partim chlorinis, margine in latera definita, in terminis definita vel indefinita, brunneis vel rufo-brunneis: mycelio subhyalino vel diluto flavido-chlorino; hyphis  $1.2-3.5 \mu$ : pycnidiis epiphyllis, subinde hypophyllis, numerosis, dispersis, globosis vel leniter in latera compressis, pallidis flavo-brunneis,  $49-83 \mu$ ; ostiolo in brevem papillam erecto,  $14-35 \mu$ : conidiis cylindrico-bacilliformibus, hyalinis,  $4.5-7 \times 1-1.4 \mu$ , utrimque rotundatis.

Specimen typicum in foliis flavidis *Smilacinae amplexicaulis* Nutt. (Liliaceae), Ouray Picnic Grounds, Ouray, Ouray County, Colorado, 12 Octobri, 1948, legerunt W. G. & Ragnhild Solheim, sub numero 2250.

Spots amphigenous, elongated, mostly limited by the major veins, 1-5.5 cm. long, 3-7 mm. wide, light brown, brown, to brownish-white, at times partly green, border definite laterally, definite to indefinite terminally, brown to reddish-brown: mycelium subhyaline to dilute yellowish-green; hyphae  $1.2-3.5 \mu$ : pycnidia epiphyllous, occasionally also hypophyllous, numerous, scattered, globose or slightly compressed laterally, light yellow-brown,  $49-83 \mu$ ; ostiole short papillate,  $14-35 \mu$ : conidia cylindrical-bacilliform, hyaline,  $4.5-7 \times 1-1.4 \mu$ , ends rounded.

On yellowing leaves of *Smilacina amplexicaulis* Nutt., Ouray Picnic Grounds, Ouray, Ouray County, Colorado, Oct. 12, 1948,

W. G. & Ragnhild Solheim No. 2250 (type) (Myc. Sax. Exs. No. 464).

This species differs from *P. vagans* Pk. in the larger spores and the production of definite spots. In *P. vagans* the pycnidia are recorded as 75–90  $\mu$  and the spores  $3 \times 1 \mu$ . *P. woronowii* Woronichin is described as having pycnidia 45–75  $\mu$  and conidia  $3 \times 1 \mu$ . It is probably not distinct from *P. vagans*. The other species of *Phyllosticta* described on *Smilacina* and related genera have ovoid and wider conidia.

***Phleospora muhlenbergiae* Sprague & Solh. sp. nov.**

Maculis coloris straminei, sine marginibus: pycnidiis dispersis vel subgregariis, innatio-erumpentibus, subcarbonaceis, subglobose, elliptico-oblongis vel obtuso-lenticularibus, nigro-brunneis, 95–245  $\times$  65–121  $\mu$ ; poro irregulariter marginato, qui videtur velut erusus, elongato-elliptico, 45–170  $\times$  38–104  $\mu$ ; conidiis subcylindraceis vel anguste obclavatis, apice subacuto, basi vergente in rotundum sed postea obtusa, curvulis vel aliquando rectis, subhyalinis vel pallide chlorino-flavidis, 21–45  $\times$  2.6–4  $\mu$ , 1–2-septatis.

Specimen typicum in foliis vivis *Muhlenbergiae arizonicae* Scribn. (Agrostideae), Oak Flats Picnic Grounds, Santa Catalina Mountains, prope Tucson, Arizona, Amer. bor., 12 Novembris, 1948, legerunt W. G. & Ragnhild Solheim, sub numero 2448.

Spots straw colored, without borders: pycnidia scattered to subgregarious, innate-erumpent, subcarbonous, subglobose, elliptical-oblong to bluntly lenticular, blackish-brown, 95–245  $\times$  65–121  $\mu$ ; pore irregularly margined, appearing as if eroded away, elongate-elliptical, 45–170  $\times$  38–104  $\mu$ ; conidia subcylindrical to narrowly obclavate, apex tapering to a softly blunted point, base round-tapering, finally blunt, subhyaline to pale greenish-yellow, curved or at times straight, 21–45  $\times$  2.6–4  $\mu$ , 1–2-septate.

On living leaf blades and sheaths of *Muhlenbergia arizonica* Scribn., Oak Flats Picnic Grounds, Santa Catalina Mountains, east of Tucson, Arizona, Nov. 12, 1948, W. G. & Ragnhild Solheim No. 2448 (type) (Myc. Sax. Exs. No. 478).

The spores of this species are smaller than those of *P. idahoensis* Sprague and *P. graminivora* Sprague & Hardison.

***Kabatia fragariae* sp. nov.**

Maculis nullis vel indefinitis vel definitis et irregularibus; superna superficiei folii nigro-punctata, aliquando folii textura cingente flavida vel atrorufa; infera folii textura aliquando paucis et minutis et nigris punctis maculata; textura infra pycnidia epiphylla leniter discolorata vel albido-flavida: mycelio



hyalino; hyphis tenuibus, circa 0.8–1.7  $\mu$ : pycnidii plerumque epiphyllis, subinde hypophyllis, numerosis, dispersis vel gregariis, dimidiatis, disparis coloris atro-brunnei et cinereo-brunnei, marginibus flavis et distincte radiatis, in lineamentis circularibus, subellipticis vel aliquantulum irregularibus, 70–376  $\times$  70–290  $\mu$ ; poro simplici elongato vel irregulariter furcato et recurvo, cum utraque superficie scutelli exhibente breves, atrobrunneas cellulas papillatas: conidiophoris clavatis, hyalinis, circa 10  $\times$  2.3  $\mu$ : conidiis falcatis, apud apicem apiculatis, ad basem attenuatis, hyalinis, 18–28  $\times$  4.5–6.5  $\mu$ , 1-septatis.

Specimen typicum in foliis vivis *Fragariae ovalis* (Lehm.) Rydb. (Rosaceae), Happy Jack Picnic Area, Laramie Mountains, Albany County, Wyoming, Amer. bor., 8 Augusti, 1942, legerunt W. G. & Ragnhild Solheim, sub numero 2114.

Spots none or indefinite or definite and irregular; upper surface of the leaf black dotted or peppered with the pycnidia, at times with the surrounding leaf tissue yellowish to dark red; lower leaf surface at times with a few, minute, black spots, leaf tissue below the epiphyllous pycnidia only slightly discolored or at times becoming whitish-yellow: mycelium hyaline; hyphae fine, about 0.8–1.7  $\mu$  in diameter: pycnidia mostly epiphyllous, occasionally hypophyllous and then below those occurring on the upper surface, numerous, scattered or so closely aggregated as to appear coalescent, dimidiate, mottled dark brown and grayish-brown, edges yellow and distinctly radiate, outline circular to subelliptical to somewhat irregular, 70–376  $\times$  70–290  $\mu$ , opening by a simple, elongate slit or by irregular, branched slits, the free ends curling back, both surfaces of the scutellum with short, dark brown, papillate cells: conidiophores clavate, hyaline, about 10  $\times$  2.3  $\mu$ : conidia falcate, apiculate at apex, tapering toward base, 18–28  $\times$  4.5–6.5  $\mu$ , hyaline, 1-septate.

On living leaves of *Fragaria ovalis* (Lehm.) Rydb., Happy Jack Picnic Area, Laramie Mountains, Albany County, Wyoming, Aug. 8, 1942, W. G. & Ragnhild Solheim No. 2114 (*type*) (Myc. Sax. Exs. No. 482).

A comparison of the species of *Kabatia* is given in table 2.

TABLE 2  
COMPARISON OF THE SPECIES OF *Kabatia*

Species	Pycnidia	Spores
<i>lonicerae</i> (Harkn.) Höhn. = <i>latemarensis</i> Bub.	110–180	24–46 $\times$ 6–9
<i>mirabilis</i> Bub.	100–180	33–55 $\times$ 7–11
<i>fragariae</i> Solh.	70–376 $\times$ 70–290	18–28 $\times$ 4.5–6.5

**Cylindrosporium corni** sp. nov.

Maculis amphigenis, supra conspicuis magis quam infra, subcircularibus angulosis vel irregularibus, minutis, 0.5–2 mm., fumosocinereis, margine angusta, elevata, atra, cingulata cingulis rufopurpureis: mycelio intercellulari, hyalino vel subhyalino; hyphis tenuibus, 0.8–2.5  $\mu$ : acervulis epiphyllis, dispersis, subcircularibus, 42–80  $\mu$ : conidiophoris hyalinis vel subhyalinis, 6–14  $\times$  2.5–3.5  $\mu$ : conidiis filiformibus, ad apicem attenuatis, flexuosis, hyalinis, 45–87  $\times$  1.5–2  $\mu$ , 1–5-septatis.

Specimen typicum in foliis vivis *Corni stoloniferae* Michx. (Cornaceae), Six Mile Gap, Platte River, Medicine Bow Mountains, Carbon County, Wyoming, Amer. bor., 7 Septembri, 1948, legit W. G. Solheim, sub numero 2224.

Spots amphigenous, more conspicuous above than below, subcircular, angular to irregular, minute, 0.5–2 mm., smoky-gray, with a narrow, raised, dark border, surrounded by a reddish-purple zone: mycelium intercellular, hyaline to subhyaline; hyphae fine, 0.8–2.5  $\mu$ : acervuli epiphyllous, scattered, subcircular, 42–80  $\mu$ : conidiophores hyaline to subhyaline, 6–14  $\times$  2.5–3.5  $\mu$ : conidia filiform, tapering upward, flexuous, hyaline, 45–87  $\times$  1.5–2  $\mu$ , 1–5-septate.

On living leaves of *Cornus stolonifera* Michx., Six Mile Gap, Platte River, Medicine Bow Mountains, Carbon County, Wyoming, Sept. 7, 1948, W. G. Solheim No. 2224 (*type*) (Myc. Sax. Exs. No. 488).

The spots are frequently localized in larger discolored areas of the leaf. In view of the fact that many of the spots are independent of these discolored areas it is possible that these discolored areas are not caused by this fungus.

**Cylindrosporium saximontanense** sp. nov.

Maculis amphigenis, subcircularibus, irregularibus vel angulosis, nervis limitatis, 2–7 mm. longis, brunneis, supra cinerescenscentibus: marginatis per nervulos supra nigrescentes, infra flavescenscentibus: mycelio intercellulari, subhyalino; hyphis 1.3–3.5  $\mu$ : acervulis innatis, nigro-punctatis, epiphyllis, subcircularibus vel leniter ellipticis, 94–160  $\times$  80–115  $\mu$ : conidiophoris 8–12  $\times$  3–3.5  $\mu$ : conidiis cylindricis vel cylindrico-fusiformibus, rectis vel leniter curvis, subhyalinis vel pallide chlorino-flavis, 28–58  $\times$  3.5–5.2  $\mu$ , non septatis.

Specimen typicum in foliis *Populi angustifoliae* James (Salicaceae), Ouray Picnic Grounds, Ouray, Ouray County, Colorado, Amer. bor., 12 Octobri, 1948, legerunt W. G. & Ragnhild Solheim, sub numero 2258.

Spots amphigenous, subcircular, irregular to angular, vein-limited, 2–7 mm. long, brown, becoming grayish above, bordered by the veins which become blackish above and yellow below: mycelium intercellular, subhyaline; hyphae 1.3–3.5  $\mu$ : acervuli

innate, black punctate under a hand lens, epiphyllous, subcircular or slightly elliptical,  $94-160 \times 80-115 \mu$ : conidiophores  $8-12 \times 3-3.5 \mu$ : conidia cylindrical to cylindrical-fusiform, straight or slightly curved, subhyaline to dilute greenish-yellow,  $28-58 \times 3.5-5.2 \mu$ , continuous.

On leaves of *Populus angustifolia* James, Ouray Picnic Grounds, Ouray, Ouray County, Colorado, Oct. 12, 1948, W. G. & Ragnhild Solheim No. 2258 (*type*) (Myc. Sax. Exs. No. 490).

This differs from *C. oculatum* Ell. & Ev. on this same host in having larger, more irregular spots and epiphyllous acervuli and in having broader, nonseptate conidia.

#### ACKNOWLEDGMENTS

Most of the work on which this paper is based has been done in the Herbarium of the University of California at Berkeley. The author expresses his sincere appreciation to Dr. Lee Bonar for providing facilities for work and for his many courtesies. The author is especially indebted to Dr. William H. Alexander, Professor Emeritus of Latin of the University of California, for checking and correcting the Latin diagnoses and for aid in compounding the specific name "*apoclastospora*."

## MINERAL OIL AND PRESERVATION OF FUNGOUS CULTURES

MARY E. STEBBINS AND WILLIAM J. ROBBINS<sup>1</sup>

Buell and Weston<sup>2</sup> reported the use of heavy mineral oil for the preservation of fungous cultures. The fungi covered by their report included few Basidiomycetes. Since we had many of this group in our collection<sup>3</sup> to which the oil method has been applied, it seems desirable to supplement their results by a report on ours. For a review of earlier literature and details of the method, the reader is referred to the article by Buell and Weston.

Beginning March 4, 1947, cultures of 1959 isolations of fungi<sup>4</sup> were transferred to 2 per cent malt agar slants. The tubes were incubated at 25° C. until growth had started (2 days to 1 week) and were then put at 15° C. until the fungi had grown over the surface of the slants (about 2 weeks from the time of inoculation). The slants were not left at 25° C. for 2 weeks because the agar became too dry. The slants were then covered with sterile mineral oil. The oil was Parke-Davis heavy mineral oil, and enough was used in each tube to come about 1 cm. above the top of the agar slant. After they were oiled, all tubes were placed in an upright position at 15° C.

Species of the following genera were treated with mineral oil:

<sup>1</sup> This investigation was supported in part by the Howard Bayne Research Fund of The New York Botanical Garden.

<sup>2</sup> Buell, Caroline B., and William H. Weston. Application of the mineral oil conservation method to maintaining collections of fungous cultures. *Am. Jour. Bot.* **34**: 555-561. 1947.

<sup>3</sup> We are indebted to a number of colleagues for the majority of our cultures. It is not possible to mention all of them but the following were especially generous: Dow V. Baxter, Ross W. Davidson, H. M. Fitzpatrick, Carl Hartley, Roger Heim, H. S. Jackson, Anna E. Jenkins, Jose Emilio Santos Pinto-Lopes, Mildred K. Nobles, Caroline T. Rumbold, H. H. Whetzel, W. Lawrence White and W. H. Wilkins.

<sup>4</sup> These included 853 identified and 100 unidentified species. The balance (1006) were duplicate isolations.

	Number of species		Number of species
ACTINOMYCETES		Calocera	1
Actinomyces	2	Calodon	1
	—	Calvatia	2
PHYCOMYCETES		Ceracea	1
Absidia	2	Claudopus	1
Conidiobolus	1	Clavaria	5
Mucor	2	Clitocybe	8
Phycomyces	2	Collybia	7
Phytophthora	1	Coniophora	6
Pythiormorpha	1	Conocybe	2
Pythium	2	Coprinus	20
Rhizopus	3	Coriolus	1
	14	Corticium	35
	—	Crepidotus	3
ASCOMYCETES		Crucibulum	1
Apioporthes	1	Cyathus	1
Ashbya	1	Cyphella	1
Botryotinia	5	Cytidia	1
Ceratostomella	19	Dacryomyces	3
Chaetomium	5	Daedalea	9
Ciboria	5	Deconica	2
Ciborinia	1	Drosophila	17
Claviceps	1	Echinodontium	1
Cryptodiaporthes	2	Eichleriella	1
Elsinoë	9	Exidia	2
Endoconidiophora	3	Favolus	2
Endothia	1	Femsonia	1
Gibberella	2	Fistulina	1
Grosmannia	1	Flammula	6
Lambertella	5	Fomes	42
Massaria	1	Fomitiporia	3
Massariovalsia	1	Galera	1
Melanconis	1	Galerina	1
Monascus	1	Ganoderma	3
Morchella	1	Gloeocystidium	1
Neurospora	3	Gloeotulasnella	1
Ophiobolus	1	Grandinia	2
Ophiostoma	1	Helicogloea	2
Pyrenochaeta	1	Hericium	2
Rutstroemia	1	Hirneola	1
Sclerotinia	9	Hydnum	10
Streptotinia	1	Hymenochaete	5
Stromatinia	2	Hypholoma	2
Teichospora	1	Hypochnus	2
Thielavia	2	Irpex	2
Xylaria	1	Lentinus	6
	89	Lenzites	10
	—	Lepiota	1
BASIDIOMYCETES		Leptoporus	1
Agaricus	1	Lycoperdon	2
Agrocybe	2	Marasmius	6
Aleurodiscus	7	Melanoleuca	1
Alnicola	2	Merulius	6
Armillaria	1	Mucidula	2
Auricularia	1	Mucronella	1
		Mycena	3
		Mycocacia	1

	Number of species		Number of species
<b>BASIDIOMYCETES (Cont'd.)</b>			
Naucoria	1	Botrytis	4
Nyctalis	1	Brachysporium	1
Odontia	7	Cadophora	2
Omphalia	3	Cephalosporium	1
Oxydontia	2	Cephalothecium	1
Panaeolina	1	Cercosporidium	1
Panaeolus	5	Chaetomella	1
Panellus	1	Chalaropsis	1
Panus	5	Cladosporium	2
Paxillus	1	Coccosporium	1
Pellicularia	3	Curvularia	4
Peniophora	30	Dendryphium	1
Phaeolus	1	Epidermophyton	2
Phallus (Ithyphallus)	1	Fusarium	1
Phellinus	2	Gliocladium	4
Phlebia	4	Gliomastix	1
Pholiota	12	Helicoma	1
Pleurotus	9	Helminthosporium	1
Pluteus	1	Heterosporium	1
Polyporus	104	Hormiactella	1
Polystictus	2	Humicola	1
Poria	67	Macrosporium	1
Psalliota	1	Memnoniella	1
Pseudocoprinus	2	Metarrhizium	3
Ptychogaster	2	Microsporium	4
Radulum	2	Monotospora	1
Schizophyllum	2	Myrothecium	3
Sebacina	3	Myxosporium	1
Solenia	1	Myxotrichella	1
Sparassis	1	Nigrospora	1
Sphaerobolus	1	Penicillium	9
Spongipellis	1	Pestalotia	4
Steccherinum	2	Phialophora	2
Stereum	24	Phoma	1
Stropharia	2	Pullularia	1
Trametes	24	Rhizoctonia	2
Trechispora	2	Sclerotium	2
Tremella	1	Scopulariopsis	2
Tricholoma	2	Sphaceloma	10
Trogia	1	Sphaeropsis	1
Tulasnella	2	Sporotrichum	2
Typhula	1	Stachybotrys	2
Ungulina	2	Stemphyllium	3
Vararia	4	Stysanus	1
Volvaria	1	Synsporium	1
Xanthochrous	3	Tetracoccosporium	1
	626	Torula	1
		Trichophyton	8
		Trichosporium	1
		Tritirachium	2
<b>FUNGI IMPERFECTI</b>			
Achorion	1	Verticicladium	1
Acladium	1	Verticillium	1
Acremonium	1	Volutella	1
Alternaria	1	Xenosporium	1
Aspergillus	7	Zygodesmus	1
Botryodiplodia	1		122

All the cultures were examined at intervals and the following observations were made:

Some of the fungi grew better under oil. Among these were species of *Corticium*, *Epidermophyton*, *Ashbya*, *Massaria*, *Melanconis*, *Nyctalis*, *Elsinoë* and *Sphaceloma*. For example, species of *Melanconis*, *Elsinoë* and *Sphaceloma*, which formed small colonies with limited growth on 2 per cent malt agar, covered the entire slant under oil.

Five types of growth under oil were noted. The numbers refer to the number of isolations in each type.

(1) The mycelium grew appressed to the agar slant. None developed in the oil. (437)

(2) The mycelium grew over the agar slant as in (1) but the mycelial surface was fuzzy. (524)

(3) The mycelium filled the oil but stopped at the surface of the oil or a short distance below it. (145)

(4) A band of mycelium ranging in thickness from less than 1 mm. to 10 mm. formed across the tube directly beneath the surface of the oil and above the top of the agar slant. The oil below this band was free of mycelium. (383)

(5) A narrow band of mycelium (2 mm. or less in thickness) formed at the top of the slant and hung down over the slant with varying amounts of oil free of mycelium above and below the band. (470)

In general, the species of each genus tended to have the same type of growth. However, there were exceptions, and in some instances isolations of the same species differed in type of growth.

The mycelium of a substantial number (153) of the cultures eventually grew up out of the oil. In such cultures evidence of partial drying of the agar slant was observed. The oiled cultures were therefore examined at intervals of six months and additional mineral oil added to those in which the mycelium appeared above the oil.

Pigments from some of the fungi dissolved in the oil. The colors ranged from tan and light yellow to a medium reddish purple, deep red or deep yellow. *Phlebia strigosozonata* and

species of *Elsinoë* and *Sphaceloma* developed pink, orange and red pigments, yellows were observed for species of *Aspergillus*, *Corticium*, *Drosophila*, *Hydnum*, *Oxydontia*, *Poria*, *Tetracoccusporium* and several others (20 genera in all). The reddish purple color was found only with cultures of *Helminthosporium*.

Some of the fungi did not develop their normal color under oil. *Corticium coeruleum* did not form its dark blue pigment, nor did species of *Fusarium* or *Gibberella* become red. *Penicillia* were white, tan or faint olive-green instead of green or blue-green.

Beginning January 21, 1948, transfers were made from the oiled cultures. Bits of mycelium were drained as free from oil as possible by patting them against the inside of the oiled tube and were transferred to fresh 2 per cent malt agar slants. The slants were incubated at 25° C. All the fungi were viable except *Pythium butleri*, *P. helicoides*, *Peniophora sambuci*, two isolations of *Sebacina cinerea* and two unidentified species of *Sebacina*. The five latter fungi grew poorly and slowly on malt agar before oiling.

In general, it was our impression that the subcultures from the oiled cultures grew more vigorously than transfers from unoled cultures.

The cultures oiled in 1947 were again tested for viability in January 1949 after two years under oil. Transfers of *Ashbya gossypii* and *Phallus* (*Ithyphallus*) sp. failed to grow; both had survived one year under oil. All others grew.

Additional fungi were treated with mineral oil in 1948. Of these, only five genera—*Acanthocystis*, *Amanita*, *Armillariella*, *Eremothecium* and *Rhodopaxillus*—were not included in the original set. All were tested after one year under oil and found to be viable.

DEPARTMENT OF BOTANY, COLUMBIA UNIVERSITY  
AND NEW YORK BOTANICAL GARDEN



## NEW CELLULOSE DESTROYING FUNGI ISOLATED FROM MILITARY MATERIAL AND EQUIPMENT

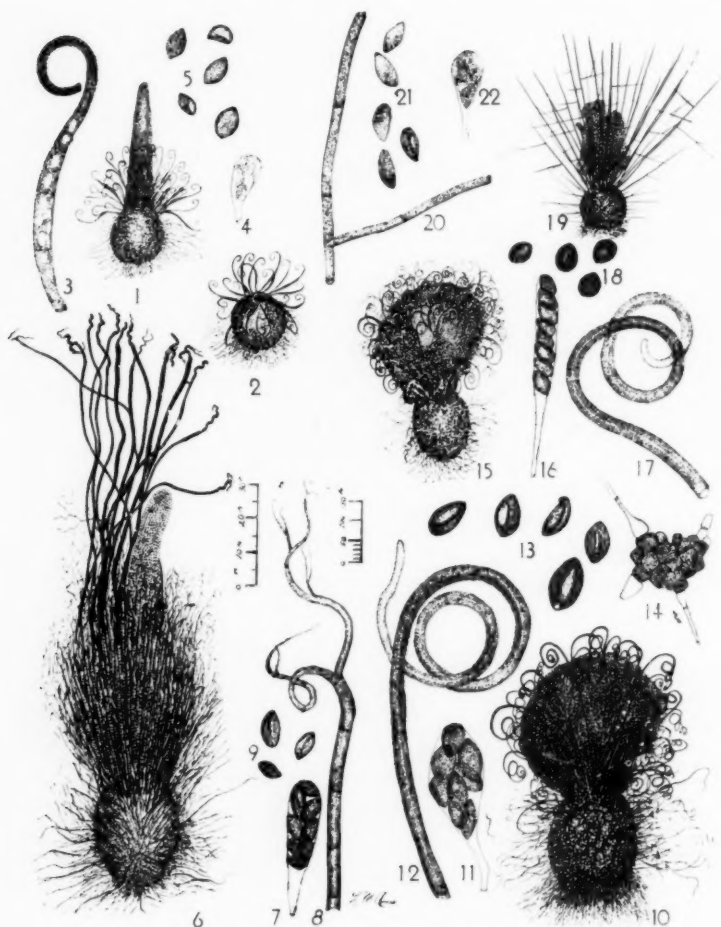
L. M. AMES \*

(WITH 42 FIGURES)

Cellulose destroying fungi are valued for their part in the process of reducing plant remains to humus for the enrichment of the soil. The magnitude of this valuable decomposition process is scarcely considered by most people because it is so commonplace and proceeds naturally and continuously. However, these organisms do not distinguish between waste cellulosic materials and the raw or fabricated cellulosic goods of value to human needs. In this latter respect, the destruction of vast quantities of goods by fungi during the recent war focused the attention of military departments on the need of finding means of preserving and lengthening the life and dependability of military equipment. This entailed identifying the organisms concerned as well as prescribing and testing preservative materials. The efforts to this end have been shared by the military departments with civilian government agencies, commercial research establishments, and college laboratories. Although much progress has been made to prolong the life and dependability of cellulosic materials, only a good start has been made to solve the many encountered problems. Many people in industry and government are synthesizing new chemical compounds designed to treat various goods to prevent mildewing. At the same time, many independent and cooperative screening tests are in progress to evaluate old and new fungicides; the more promising are put through many additional exacting evaluation tests. Paralleling these researches, the fungi responsible for mildewing have received considerable attention.

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Many and various kinds of fungi have been isolated from deteriorating equipment at home and in foreign areas; these fungi have been studied both as to their identity and their physical char-



FIGS. 1-22. New species of *Chaetomium*.

acteristics. In the course of isolating and studying fungi from rotting equipment, new organisms, from time to time, have been discovered following which their morphology and growth charac-

teristics were observed. This paper is concerned primarily with nine hitherto undescribed species of mildew-producing fungi belonging to the genus *Chaetomium*. These are illustrated and described below.

***Chaetomium turgidopilosum* sp. nov. Figs. 1-5.**

Peritheciis pullis, ostiolatis, globosis vel ovatis,  $120-140 \times 115-135 \mu$ , cirrhis conspicuis provisitis et rhizoideis tenellis ad substratum affixis. Pilis lateralibus numerosis, distincte septatis, tenuibus. Pilis terminalibus robustis, rigidis, distincte septatis, basi dilute brunneis supra pallidioribus, medio plerumque plus minusve inflatis,  $5-8 \mu$  latis, in apicibus frequenter recurvatis angustatis. Ascis clavatis, octosporis,  $20-22 \times 9.5-11.5 \mu$ , parte sporifera  $15 \mu$ . Ascosporis maturis brunneis, limoniformibus, utrinque leniter apiculatis,  $8-11 \times 4-7 \mu$ .

Perithecia soiled gray in color, ostiolate, globose to ovate,  $120-140 \times 115-135 \mu$ , provided with conspicuous cirrhi, attached to the substratum with delicate rhizoids. Lateral hairs numerous, distinctly septate, tapering. Terminal hairs large, rigid, distinctly septate, light brown at the base, lighter in the usually inflated middle section, narrower and darker at the recurved apex. Asci clavate, eight-spored,  $20-22 \times 9.5-11.5 \mu$ , spore part  $15 \mu$ . Mature ascospores are brown, lemon-shaped somewhat apiculated at both ends,  $8-11 \times 4.7 \mu$ .

**Type**—isolated from the top of a storage tent. Culture was made by Dr. G. W. Martin and sent to the writer under the designation J-730 APO 929 (A-lff).

This species is easily recognized by the distinctively inflated terminal hairs which are reflexed at their tips.

***Chaetomium cristatum* sp. nov. Figs. 6-9.**

Peritheciis griseis, magnitudinis mediae, ovatis in subglobosis gradientibus, ostiolatis,  $250-300 \times 175-225 \mu$ , cum rhizoideis brunneis dilutis paratis. Pilis lateralibus copiosis, gracilibus, septatis, apicibus acuminatis. Pilis terminalibus typorum duorum: (a) aliis numerosis septatis, simpliciter vel compositis ramosis, basi  $3-4 \mu$  diametro, apicibus subtiliter divisitis, peritheciis bysso similibus sedentibus; (b) aliis parvis, longis, atris, basi  $6-8 \mu$  diametro, pilos byssinos excedentibus, interdum in madore anastomosantibus quandoque apice ramis parvulis. Ascis clavatis, octosporis,  $45 \times 12 \mu$ , parte sporifera  $28 \mu$ . Ascosporis maturis ovatis, umbonatis vel subapiculatis, olivaceo-brunneis,  $8-12 \times 4.5-6 \mu$ .

Perithecia gray, of medium size, ovate to subglobose, ostiolate,  $250-300 \times 175-225 \mu$ , attached to the substrate with light brown

rhizoids. Lateral hairs are numerous, slender, septate and gradually decreasing in diameter to the apex. The terminal hairs are of two types: (a) the first are numerous, septate, branched and re-branched, at the base  $3-4\ \mu$  in diameter and decreasing to thin tips giving the plant a fuzzy appearance; (b) the second are few in number, long and black, at the base  $6-8\ \mu$  in diameter, extending through and beyond the first type, are occasionally seen anastomosed near the tips which are sometimes abruptly frayed with little branches. Asci clavate, eight-spored,  $45 \times 12\ \mu$ , spore part  $28\ \mu$ . Ascospores, when mature, are umbonate to subapiculate, olive-brown,  $8-12 \times 4.5-6\ \mu$ .

**Type**—isolated from paper carton under test in the Tropical Testing Chamber, Fort Belvoir, Virginia.

***Chaetomium gangligerum* sp. nov.** Figs. 10-14.

Peritheciis fulvis, ostiolatis, magnitudinis mediae, ovatis in subglobosis gradientibus,  $230-260 \times 190-210\ \mu$ , sine cirrho, rhizoideis numerosis ad substratum affixis. Pilis lateralibus copiosis, gracilibus, septatis, apicibus acuminatis. Pilis terminalibus numerosis, distincte vel obscure septatis, tenuibus barbellatis, basi rectis vel arcuatis, fulvis, diametro  $3.5-4.25\ \mu$ , apice spiralliter recurvatis. Ascis clavatis, octosporis,  $50 \times 18\ \mu$ , parte sporifera  $36\ \mu$ . Ascosporis maturis brunneis, ovatis vel globoso-ovatis, umbonatis vel subapiculatis  $12-18 \times 7-11\ \mu$ . In media agar-agar cum liquore tuberis *Solani tuberosi*, et farina *Zea Maydis*, nodulorum hypogaeorum fuscorum varietatem forma et magnitudine differentibus, copiosam producens.

Perithecia tawny yellow, ostiolate, moderately large, ovate to subglobose,  $230-260 \times 190-210\ \mu$ , without cirrhi, attached to the substratum with numerous rhizoids. Lateral hairs are numerous, slender, septate and gradually decreasing in diameter to the apex. Terminal hairs numerous, distinctly or obscurely septate, coated with many little barbules, straight or curved from the base, tawny yellow in color,  $3.5-4.25\ \mu$  in diameter, spirally recurved at the apex. Asci clavate, eight-spored,  $50 \times 18\ \mu$ , spore part  $36\ \mu$ . Mature ascospores brown, ovate to globose-ovate, umbonate to subapiculate,  $12-18 \times 7-11\ \mu$ . In agar-agar media enriched with potato and corn meal broth, dark colored bulbils are formed in a variety of shapes and in large numbers.

**Type**—isolated from wood samples which were under test in the Tropical Testing Chamber, Fort Belvoir, Virginia.

This species is easily distinguished in culture because of the dark-celled bulbils it produces in the agar.

**Chaetomium velutinum** sp. nov. Figs. 15-18.

Peritheciis griseis, parvis, ovatis in subglobosis gradientibus, ostiolatis,  $150-180 \times 120-140 \mu$ , interdum cum cirrho, rhizoideis numerosis, vix ad substratum affixis. Pilis lateralibus numerosis, gracilibus. Pilis terminalibus numerosis, septatis, gracilibus, barbellatis, diametro  $4-5 \mu$ , apice cum 1-3 convolutis. Ascis longis, cylindricis, octosporis,  $65 \times 7 \mu$ , parte sporifera  $38-42 \mu$ . Ascosporis maturis olivaceo-brunneis dilutis, limoniformibus, umbonatis vel subapiculatis,  $6.75-8.5 \times 4-6 \mu$ .

Perithecia gray, small, ovate to subglobose, ostiolate,  $150-180 \times 120-140 \mu$ , occasionally producing cirrhi, lightly affixed to the substratum with numerous rhizoids. Lateral hairs numerous, slender. Terminal hairs numerous, septate, graceful,  $4-5 \mu$  in diameter, covered with little spines, and at the apex coiled in 1-3 convolutions. Asci long, cylindrical, eight-spored,  $65 \times 7 \mu$ , spore part  $38-42 \mu$ . Mature ascospores dilute olive-brown, lemon-shaped, umbonate to subapiculate,  $6.75-8.5 \times 4-6 \mu$ .

**Type**—isolated from a Japanese tent. Culture was made by Dr. G. W. Martin and sent to the writer under the designation J-359-APO 565 (J-lm).

This small, silver-gray species is easily distinguished by its cylindrical asci in which the spores are monostichous.

**Chaetomium atrobrunneum** sp. nov. Figs. 19-22.

Peritheciis fuscis, parvis, ostiolatis, globosis vel subglobosis,  $80-120 \times 80-110 \mu$ , vel cirrhis vel sporis laxe acervatim in pilis terminalibus adhaerentibus, ad substratum rhizoideis stramineis affixis. Pilis lateralibus numerosis, tenuibus, distincte septatis, apice gradatim attenuatis. Pilis terminalibus longis, gracilibus, basi  $3.75-4.75 \mu$  diametro, saepe ramosis divaricatis, distincte septatis, apice gradatim attenuatis. Ascis clavatis, octosporis  $30 \times 10 \mu$ , parte sporifera  $18 \mu$ . Ascosporis maturis pallidis olivaceo-brunneis, longis et angustis, paullo fusiformibus, utrinque rotundatis vel subacutis,  $10-12 \times 5.5-7.5 \mu$ .

Perithecia dark brown, small, ostiolate, globose to subglobose,  $80-120 \times 80-110 \mu$ , with cirrhi or with masses of spores loosely held in the terminal hairs, affixed to the substratum with straw-colored rhizoids. Lateral hairs numerous, slender, distinctly septate, gradually narrowing in diameter to the tips. Terminal hairs long, graceful, at the base  $3.75-4.75 \mu$  in diameter, often branched with wide angles to the main axis, distinctly septate, narrowing in diameter to a relatively sharp tip. Asci clavate, eight-spored,  $30 \times 10 \mu$ , spore part  $18 \mu$ . Mature ascospores dilute olive-brown, long

and narrow, somewhat fusiform, rounded to subacute on the ends,  $10-12 \times 5.5-7.5 \mu$ .

**Type**—isolated from a molded mattress cover from Guadalcanal. Culture was made by Dr. G. W. Martin and sent to the writer under the designation J-1041-(3-J3).

This species is readily distinguished by the rich brown terminal hairs which are branched with wide angles.

**Chaetomium seminudum** sp. nov. Figs. 23-29.

Peritheciis parvis, nigris, vasiformis,  $150 \times 70 \mu$  ( $100-165 \times 65-85 \mu$ ), ostiolatis, cum cirrhis longis, ad substratum rhizoideis tenellis affixis. Pilis lateralibus et terminalibus uniformibus, paucis, septatis, basi  $3.5-4 \mu$  diametro, apice gradatim attenuatis. Ascis clavatis, octosporis, maturitatem ante dissolutis. Ascosporis maturis olivaceo-brunneis dilutis, globoso-ovatis, extremo altero rotundatis, extremo alio subacutis,  $13.5 \times 11 \mu$  ( $9-14 \times 7-8 \mu$ ). In media agar-agar cum liquore tuberis, *Solani tuberosi*, et farina, *Zea Maydis*, chlamydosporas copiosas producents.

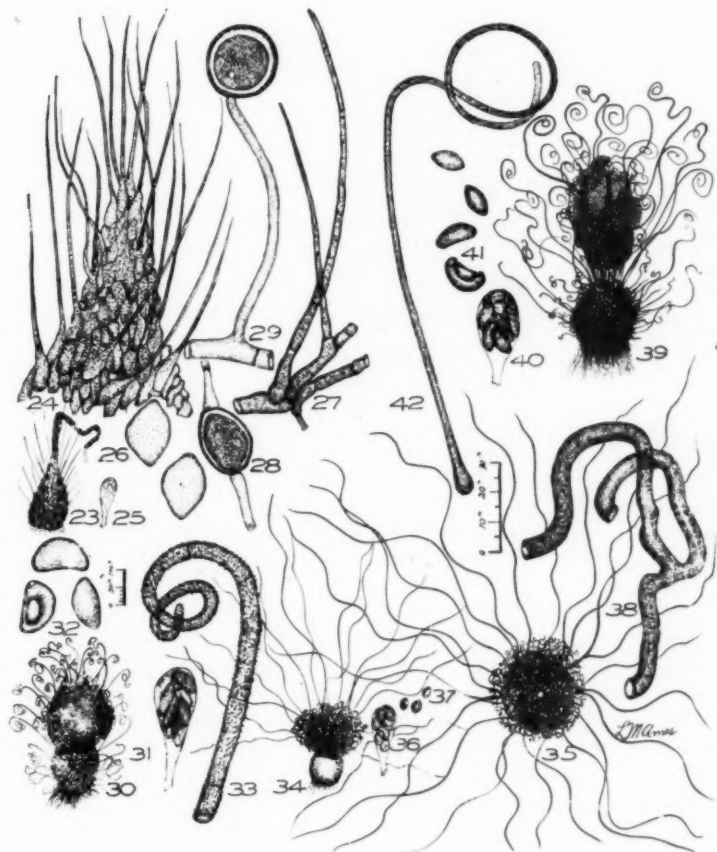
Perithecia small and black, vase-shaped,  $150 \times 70 \mu$  ( $100-165 \times 60-85 \mu$ ), ostiolate, with long cirrhi, attached to the substratum with translucent mycelium-like rhizoids. Lateral hairs and terminal hairs are alike, few in number, septate, at the base  $3.5-4 \mu$  in diameter, narrowing to a sharp tip. Asci clavate, eight-spored, liquefying before the spores mature. Mature spores light olive-brown, globose-ovate, the ends rotund to subacute in shape,  $13.5 \times 11 \mu$  ( $9-14 \times 7-8 \mu$ ). In agar-agar media enriched with potato and corn meal extract, myriads of chlamydospore-like bodies  $10-15 \mu$  in diameter are produced. Most of these bodies are borne on the ends of short slender stalks  $30-50 \mu$  in length by  $2 \mu$ ; some are of intercalary origin (FIGS. 28 and 29). Scattered on the agar surface, very often, are hair-like structures which resemble the ornamental perithecial hairs (FIG. 27).

This interesting species was sent to the writer by Dr. J. C. Gilman, Iowa State College, Ames, Iowa. The plant is easily distinguished from all other described species of *Chaetomium* by its small seminude, vase-shaped perithecium and, in culture, by the copious formation of the chlamydospore-like bodies within the substratum.

**Chaetomium cupreum** sp. nov. Figs. 30-33.

Peritheciis parvis, ostiolatis, globosis vel ovatis,  $110-120 \times 120-130 \mu$ , cirrhis conspicuis, rhizoideis tenellis ad substratum affixis. Pilis lateralibus

numerosis, gracilibus, distincte septatis, basi 3-3.5  $\mu$  diametro, apice 1-2 convolutis. Pilis terminalibus rigidis, distincte septatis, basi 4.5-6  $\mu$  diametro, apice 1-3 convolutis. Pilis lateralibus et terminalibus granulis cuprinois vestitis. Ascis clavatis, octosporis,  $38 \times 13 \mu$ , parte sporifera 27  $\mu$ . Ascosporis maturis, globoso-ovatis, subapiculatis,  $10 \times 5.5 \mu$  (8.5-11.5  $\times$  5-5.5  $\mu$ ).



FIGS. 23-42. New species of *Chaetomium*.

Perithecia bright copper colored, small, ostiolate, globose to ovate,  $110-120 \times 120-130 \mu$ , with conspicuous cirrhi; attached to the substratum with undifferentiated rhizoids. Lateral hairs numerous, slender, distinctly septate, 3-3.5  $\mu$  in diameter at the base, and at the apex with 1-2 convolutions. The terminal hairs are



rigid, distinctly septate,  $4.5-6\ \mu$  in diameter at the base with 1-3 convolutions at the apex. Lateral and terminal hairs are covered with small grains which are copper colored. Asci clavate, eight-spored,  $38 \times 13\ \mu$ , spore part  $27\ \mu$ . Mature ascospores globose-ovate, subapiculate,  $10 \times 5.5\ \mu$  ( $8.5-11.5 \times 5-5.5\ \mu$ ).

This bright colored species was first sent to the writer by Dr. Paul Marsh, U. S. Department of Agriculture, Beltsville, Md., who obtained it from deteriorating material collected in Panama Canal Zone. A second collection was sent to the writer by Dr. G. W. Martin who isolated it from material shipped from Guadalcanal. This species is distinguished from other *Chaetonia* by its bright copper colored hairs. The pigment granules dissolve in alcohol, ether, cellosolve, and xylol, but not in water.

***Chaetomium causiaeformis* sp. nov. Figs. 34-38.**

Peritheciis parvis, delicatulis, translucidis, ostiolatis, globosis vel subglobosis,  $80-100 \times 80-90\ \mu$ , sine cirrho, rhizoideis numerosis, vix ad substratum affixis. Pilis lateralibus paucis, gracilibus, translucidis, distincte septatis, tennibus, basi  $1.25-2\ \mu$  diametro. Pilis terminalibus typorum duorum: (a) aliis brevibus numerosis circa ostiolis, septatis, compositis ramosis, basi  $3-4\ \mu$  diametro, causia similibus. (b) aliis longis, undulatis,  $4.25-5\ \mu$  diametro, tenuibus barbellatis, apicibus acuminatis, usque ad  $1800\ \mu$  longis. Ascis clavatis, octosporis,  $23 \times 8\ \mu$ , parte sporifera  $18\ \mu$ . Ascosporis maturis brunneis dilutis, ovatis vel subglobosis,  $5 \times 4\ \mu$  ( $4.75-5.25 \times 3.0-4.5\ \mu$ ).

Perithecia small, delicate, translucent, ostiolate, globose to subglobose,  $80-100 \times 80-90\ \mu$ , without cirrhi, rhizoids numerous, lightly attached to the substratum. Lateral hairs are few in number, slender, translucent, distinctly septate, tapering, at the base  $1.25-2\ \mu$  in diameter. Terminal hairs are of two types: (a) those which are short and arranged closely about the ostiole, septate and branched, at the base  $3-4\ \mu$  in diameter, in general simulating a hat. (b) those which are long, unbranched and undulating,  $4.25-5\ \mu$  in diameter, covered with very small barbules, tapering toward the apex, often reaching a length of  $1800\ \mu$ . Asci clavate, eight-spored,  $23 \times 8\ \mu$ , spore part  $18\ \mu$ . Mature asci are dilute brown, ovate to subglobose,  $5 \times 4\ \mu$  ( $4.75-5.25 \times 3.0-4.5\ \mu$ ).

This species is distinguished by the most delicate perithecium among the *Chaetonia* that the writer has observed. This fungus was sent to the writer by Dr. G. W. Martin and was designated as J-1334.



***Chaetomium succineum* sp. nov. Figs. 39-42.**

Peritheciis magnitudinis mediae, globosis vel ovatis,  $225-350 \times 140-230 \mu$ , ostiolatis, cirrhis frequenter provisus, rhizoideis tenellis ad substratum affixis. Pilis lateralibus numerosis, gracilibus, septatis. Pilis terminalibus numerosis, in cumulis autem laxiformibus, cirrhos fractos superportantibus. Pilis terminalibus gracilibus, diametro  $3.5-4 \mu$  basi, apicibus obtusis acuminatis, septatis, apice 1-3 convolutis laxis. Ascis clavatis, octosporis,  $35 \times 15 \mu$ , parte sporifera  $27 \mu$ . Ascosporis maturis pallide olivaceo-brunneis, globoso-ovatis, utrinque rotundatis vel subacutis,  $14 \times 7.5 \mu$  ( $12-15 \times 7-8 \mu$ ).

Perithecia of medium size, globose to ovate,  $225-350 \times 140-230 \mu$ , ostiolate, frequently provided with cirrhi, attached to the substratum with delicate rhizoids. Lateral hairs numerous, slender, septate. Terminal hairs numerous, of a beautiful amber color, formed in a loose cluster which holds fragmented cirrhi. Lateral hairs are graceful,  $3.5-4 \mu$  in diameter, septate, acuminate to a blunt apex which is coiled with 1-3 convolutions. Asci clavate, eight-spored,  $35 \times 15 \mu$ , spore part  $27 \mu$ . Mature ascospores are of a pale olive-brown, globose-ovate, rounded to subacute at the ends,  $14 \times 7.5 \mu$  ( $12-15 \times 7-8 \mu$ ).

This species is distinguished by the loose cluster of slender amber-colored hairs which ornament the apex of the perithecium. The perithecia, in culture, are numerous but not crowded. Cultures were sent to the writer by Dr. G. W. Martin and by Mr. William B. Cooke, Pullman, Washington.

## DISCUSSION

Type specimens of each species have been deposited at the Farlow Herbarium, Cambridge, Massachusetts, and co-types at the U. S. Department of Agriculture, Beltsville, Md.

Some of the species of *Chaetomium* described in this paper were isolated from rotting mattresses, tenting, knapsacks, clothing and other items of equipment from various islands in the Pacific combat areas. These plants were sent to the writer for identification and study by Dr. G. W. Martin and Miss Louise G. Isfort from the Jeffersonville Quartermaster Depot, Jeffersonville, Indiana. Several specimens were received from Mr. William B. Cooke, Pullman, Washington and Dr. Paul Marsh, Bureau of Plant Industry, Washington, D. C. For their kindness in sending the many specimens, and for the assistance of Dr. Hugh T. O'Neill at Catho-

lic University in revising my Latin descriptions, I wish to express my deep appreciation. Additional species, discovered by the writer, were found growing on material and equipment in the Tropical Testing Chamber, Fort Belvoir, Virginia. The first fungus belonging to the genus *Chaetomium*, as now understood, was described more than 131 years ago.

Kunze erected the genus *Chaetomium* in 1817 based upon the species *C. globosum*; a second species, *C. elatum*, was published by him a year later. In 1837 Corda emended Kunze's original description principally by describing the ostiolum; two new species, *C. indicum* and *C. murorum*, were added to the genus by him at that time. Descriptions of new species have appeared rather infrequently since the erection of the genus, and many of the later names have been determined subsequently to be synonyms or to have been erroneously applied. Three small monographic papers were published by Zopf (1881), Palliser (1910), and Bainier (1910). These were followed by a much more complete monographic treatment of the genera *Chaetomium* and *Ascotricha* in 1915 by Chivers. In this excellent monograph, of the 114 species and 14 varieties which were referred to the genus *Chaetomium*, he recognized only 28 species, 11 of which he described as new. Most of the species were beautifully illustrated, thus making identifications relatively easy and accurate. More recently, Tschudy (1937) described two species, *C. ochraceum* and *C. cancroideum*, which were isolated from decomposing reeds. In 1945 Hughes described a 4-spored species, *C. tetrasporum*. In the same year, Ames described three additional species, *C. dolichotrichum*, *C. microcephalum*, and *C. pachypodioides*. In a recent paper Skolko and Groves described two new species, *C. erectum* and *C. reflexum*, which were isolated from various types of seeds.

The species of *Chaetomium* described in this paper were grown in pure culture on the following medium:

NaNO <sub>3</sub>	3.0 gms.
MgSO <sub>4</sub> ·7H <sub>2</sub> O	0.5 gm.
K <sub>2</sub> HPO <sub>4</sub>	1.0 gm.
KCl	0.2 gm.
Potato extract	50 ml.
Corn meal extract	50 ml.
Distilled water to make	1,000 ml.

On this medium strips of sterilized paper or 5 oz. cotton cloth were placed as a source of carbon. The cultures were grown in an incubation chamber maintained at a temperature of 85° F. and at a relative humidity of 85%. The same features of the species, as herein described, should be obtained when grown on the medium and under the conditions outlined. Some growth characteristics were observed, during the present study, which were not previously associated with the genus.

Conidia have not been authentically described hitherto for *Chaetomium* in spite of the fact that two closely related genera, *Chaetomidium* and *Ascotricha*, produce them abundantly. Recently, the writer has observed bulbils produced, in the agar medium, by one species, *C. gangligerum*, see figure 14. These bodies have not been fully investigated as yet to determine their reproductive capacity. A second species, *C. seminudum*, produces abundant bodies, see figures 28 and 29, borne apically and singly on slender branches, or occasionally they are of intercalary origin. These bodies are produced submerged in the agar culture medium in such numbers that the agar appears cloudy. These chlamydospore-like bodies will be studied more critically and reported on subsequently.

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## EXPLANATION OF FIGURES

FIGS. 1 and 2, mature perithecia of *C. turgidopilosum*; 3, detail of a terminal hair; 4 and 5, ascus and ascospores; 6, mature perithecium of *C. cristatum*; 7, ascus with contained ascospores; 8, detail of type (a) terminal hair; 9, mature ascospores; 10, mature perithecium of *C. gangligerum*; 11, ascus with contained ascospores; 12, detail of terminal hair; 13, mature ascospores; 14, detail of "knots" or bulbil development; 15, mature perithecium of *C. velutinum*; 16, ascus with contained ascospores; 17, detail of terminal hair; 18, mature ascospores; 19, mature perithecium of *C. atrobrunneum*; 20, detail of branched terminal hair; 21, mature ascospores; 22, ascus with contained ascospores; 23, mature perithecium of *C. seminudum*; 24, detail of perithecium apex; 25, immature ascus; 26, mature ascospores enlarged by oil mount and  $15\times$  eye piece; 27, hairs from agar surface; 28 and 29, chlamydospore-like bodies enlarged by oil mount and  $15\times$  eye piece; 30, mature perithecium of *C. cupreum*; 31, ascus with contained ascospores; 32, mature ascospores; 33, detail of terminal hair; 34 and 35, mature perithecia of *C. causiiformis*; 36, ascus with contained ascospores; 37, mature ascospores; 38, detail of short terminal hair surrounding the ostiole; 39, mature perithecium of *C. succineum*; 40, ascus with contained ascospores; 41, mature ascospores; 42, detail of terminal hair.

## WYNNEA AMERICANA

RICHARD P. KORF

(WITH 1 FIGURE)

One of the rarer Operculate Discomycetes is *Wynnea americana* Thaxter, easily recognizable by the many spoon-shaped apothecia arising from a fleshy, hypogeous "sclerotium" (FIG. 1), the characteristically striate spores, and the eccentric ascus operculum. This short note is a report of some collections from New York and from West Virginia, extending the known range of this species.

In a recent and excellent paper, Le Gal (2) has discussed the morphology of the ascus tip in this and several other related fungi which comprise a new group, the Suboperculates, somewhat intermediate between Operculates and Inoperculates. Her treatment covers representatives of *Plectania* (sub *Sarcoscypha*), *Cookeina*, *Phillipsia*, *Pithya*, *Urnula*, *Rhizopodella* (sub *Urnula*), *Bulgaria* (sub *Sarcosoma*), *Pseudoplectania*, *Melascypha*, and *Wynnea*. In an earlier paper (3), delayed in publication, she had united these same genera into the family Sarcoscyphaceae, stressing spore ornamentation. Dr. Le Gal's disposition of these forms seems most natural, and the writer's observations have thus far been in full accord with hers.

*Wynnea americana* is known from several North American localities, including Tennessee, North Carolina, Ohio, and southern Pennsylvania (4). More recently it has been reported from additional Pennsylvania stations (1, 5).

Several unrecorded collections extend the northerly range of this species approximately sixty miles beyond the known limit at Meadville, Crawford County, Pennsylvania (4). Three collections made in the Lloyd-Cornell Preserve at Ringwood, New York, about seven miles east of Ithaca, are the most northerly collections known to the writer. Two collections from West Virginia, kindly communicated by Dr. H. L. Barnett, are also reported here.



FIG. 1. *Wynnea americana* Thaxter. Photograph, natural size, of a clump of apothecia; the soil surface was at the constriction just above the "sclerotium."

The specimens examined which extend the known distribution are deposited as follows:

NEW YORK—Gordon, Rea, et al., *Big Basin Forest, Allegany State Park, Cattaraugus Co., Aug. 16, 1935*: NYBG.—H. M. Fitzpatrick and C. T. Rogerson, *Ringwood, Tompkins Co., Sept. 26, 1947*: CTR; RPK.—R. E. Perkins and R. P. Korf, *same locality, Sept. 27, 1947*: CU-P 37137; NYBG; RPK.—do., *another collection*: RPK.

WEST VIRGINIA—H. L. Barnett, *Cooper Rock State Forest, Monongalia Co., August 30, 1947*: WVU.—W. C. Legg, *Mt. Lookout, Nicholas Co., November 1947*: WVU.

The writer wishes to express his appreciation to Mr. W. R. Fisher, who made the excellent photograph accompanying this note (CU-P 37137). In this specimen the hymenium was a light rose-pink color, much lighter than that usually ascribed to this species. The other two collections from Ringwood were well past their prime, and some deterioration had already occurred; in these the hymenial color was a deep purple-red. They more closely approximated the appearance of the photograph in the book by Dr. Seaver (5: plate 16), to whom the writer is indebted for the loan of material from the New York Botanical Garden.

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## CYATHUS VERNICOSUS, ANOTHER TETRAPOLAR BIRD'S NEST FUNGUS

HAROLD J. BRODIE

(WITH 2 FIGURES)

The recent studies of Dr. Nils Fries of Sweden and of the writer concerning sexuality in the Nidulariaceae have shown that all species thus far examined are heterothallic and tetrapolar. The species of this group of fungi for which four-mating-type heterothallism has been established are:

<i>Crucibulum vulgare</i> Tul.....	Fries, 1936 (3)
<i>Cyathus stercoreus</i> Schw. (De Toni).....	Brodie, 1948 (1, 2)
<i>Cyathus striatus</i> Willd.....	Fries, 1936 (3)
<i>Nidularia pisiformis</i> (Roth.) Zell.....	Fries, 1948 (4)

To this list may now be added *Cyathus vernicosus* DC. This fungus is of fairly common occurrence in gardens, where it often grows among dead plant stems or around board edging. In greenhouses it has been found on flats of soil. The species is readily recognized by its buff-grey color, wide flaring mouth and large peridioles (FIG. 2). The inside surface of the cup usually has a shiny or varnished appearance.

In 1920, Dr. Leva Walker (5) published an account of *C. vernicosus* mainly from the point of view of the developmental morphology of the fruit body. It was shown that basidiospores contain two nuclei and that two nuclei are regularly present in each cell of the diploid mycelium which bears clamp connections. Since Miss Walker did not succeed in obtaining a series of monosporous mycelia, the question of whether the fungus is homothallic or heterothallic was left unanswered.

By growing diploid mycelium on sterile loam, old leaves and half-rotten wood, Miss Walker obtained fruit bodies in the laboratory and full details of every step in the development of the fruit bodies and their peridioles were described.



## MATERIALS AND METHODS

The first attempt made by the writer to culture this fungus was in 1941. An abundant supply of fruit bodies was found in a garden in Winnipeg, Canada, where the little cups were growing around the bases of dead chrysanthemum stalks. Spores from chopped peridioles were placed in distilled water and in various nutrient solutions at room temperature. So few spores (1-3%) germinated in any test that the attempt to obtain a series of monosporous mycelia was abandoned. Several efforts were made subsequently to germinate enough spores for study, but always with the same unsatisfactory result. Similar difficulty was reported by Miss Walker (5).

When it had been learned that the basidiospores of *Cyathus stercoreus* germinate well after being subjected to a temperature of 40° C. for 48 hrs.—see Brodie, 1948 (1)—fresh material of *C. vernicosus* was sought. The writer is indebted to Mr. Garnet Best of Winnipeg, Canada, for three fruit bodies collected by him in that city, Oct. 19, 1947. These specimens provided the single-spore cultures used in the present investigation.

The spores were not tested for germinability until Nov. 19, 1948, exactly a year after the fruit bodies had been collected. Peridioles were cut open under aseptic conditions and spores in a distilled water suspension were incubated at 40° C. for 48 hours, using exactly the same technique as has been described by the writer (1) in his report on *C. stercoreus*.

Plate dilutions were made and single spores cut out under the microscope. The mycelia that developed were transferred to tube slants of a special medium compounded as follows: Bacto agar, 20 gm.; maltose, 5 gm.; dextrose, 2 gm.; glycerine, 2 gm.; peptone, 0.2 gm.; asparagine, 0.2 gm.; yeast extract, 2 gm.; magnesium sulphate, 0.5 gm.; calcium nitrate, 0.5 gm.; dihydrogen potassium phosphate, 0.5 gm.; ferrous sulphate, trace; distilled water to make 1 liter.<sup>1</sup> Using this medium, optimum vegetative growth at room

<sup>1</sup> Two of the ingredients were inadvertently omitted from the formula as given in a previous article (2) and the corrected formula is therefore given herewith.

temperature was obtained when the acidity of the medium was adjusted to pH 6.5.

Sixty monospore mycelia were isolated but only twenty-nine of these were used in the study of pairing reactions.

#### SPORE GERMINATION AND HAPLOID MYCELIA

The basidiospores of *C. vernicosus* are moderately thin-walled, colorless and (in the collection referred to above) measure mostly  $7 \times 11 \mu$ . Spores began to germinate 24 hours after the heat treatment, but some germinated tardily a day later. From 40–60% of the spores germinated in each of the different spore samples. A single stout germ tube developed from each spore and this rapidly grew into a haploid mycelium.

Haploid mycelia growing on agar plates are fluffy and fine-textured. Of twenty-nine, selected at random for pairing, only six showed any tendency to produce the coarse mycelial cords characteristic of the diploid mycelia, the rest remained fine-textured throughout numerous transfers.

Haploid mycelia show only slight morphological differences when monospore cultures are compared. As to color, they are all snow-white when freshly transferred and most of them become a dull ivory color about two weeks later. Four of the series of the original sixty isolates were buffy brown (Ridgway). No attempt has been made to study the inheritance of color because the color differences between haploids are not so striking as they are in *C. stercoreus*, nor are the colors so constant from transfer to transfer.

No haploid mycelium has been observed to produce oidia nor to produce fruit bodies in culture.

#### PAIRING REACTIONS AND DIPLOID MYCELIUM

Twenty-nine haploid mycelia were paired in all possible combinations in the usual way on agar slants. Diploid mycelium began to develop between certain pairs ten days later. All mycelial pairs were examined for clamp connections at the end of two weeks. On the basis of their mating reactions, the haploid mycelia fell into four mating types with the following distribution:

Mating type	Culture number <sup>2</sup>
AB.....	1, 4, 5, 7, 15, 16, 20, 29
ab.....	2, 8, 14, 24, 27
Ab.....	3, 6, 10, 13, 17, 19, 21, 22, 23, 25, 26, 28, 30
aB.....	12, 18

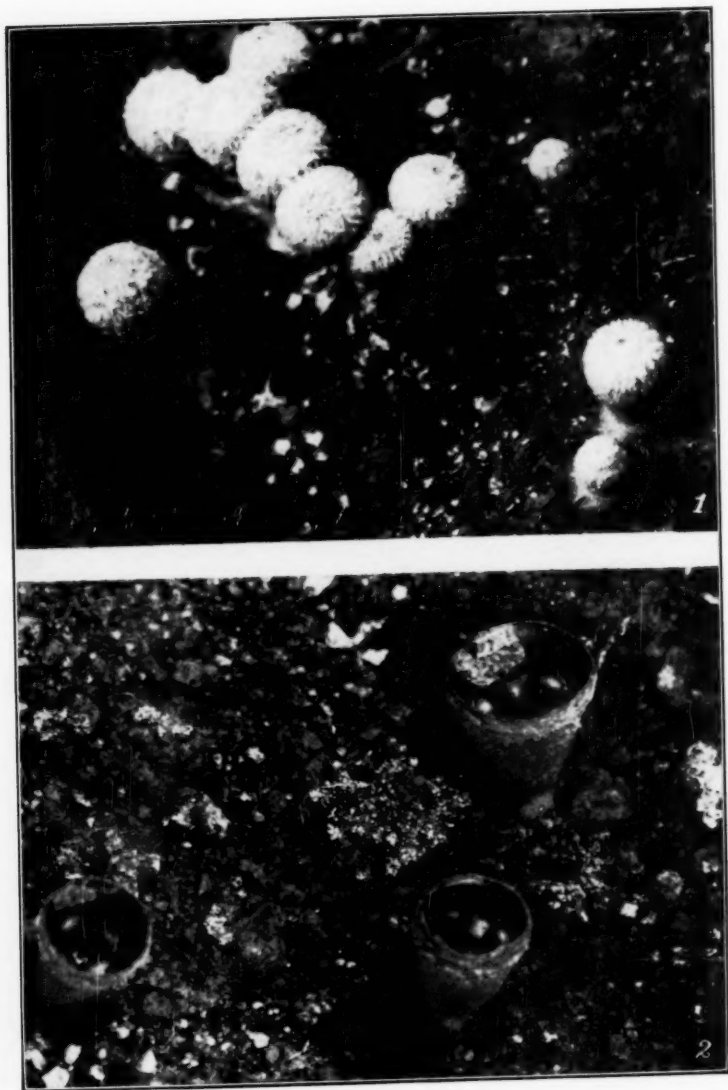
It would thus appear that *Cyathus vernicosus*, like all other members of the Nidulariaceae examined up to the present time, is heterothallic and tetrapolar. The distribution of haploid mycelia among the four sex groups is very unequal, similar to the distribution previously noticed by the writer (1) in *C. stercoreus*. From a small number of pairings, this might be considered to have no special significance. However, Dr. Nils Fries has informed the writer (by letter) that he attempted an analysis of sexuality of the European *C. olla* (Batsch) Pers. (*C. vernicosus*) and found that 23 monosporous mycelia fell into four groups in the ratio of 1:11:10:1. Because two groups were represented by only one mycelium each, Fries did not publish his results. Fries' finding furnishes corroboration for the present writer's opinion that this unequal distribution is a common occurrence and that there is some factor operative in determining the unequal distribution of mycelia as to mating type. This may well be similar to what has been observed in *C. stercoreus* (1).

Diploid mycelia bearing clamp connections are mostly white or pale ivory in color and are composed of hyphae that are somewhat coarser than are those of haploid mycelia. The hyphae of the diploid mycelium tend to become aggregated into loose ropes or cords, which give to a colony on an agar plate a characteristic radiate appearance. Some coarse mycelial cords form as colonies get older, and on these the fruit body rudiments develop. Cords of this kind are not as abundant on the diploid mycelium of *C. vernicosus* as they are on *C. stercoreus* mycelium.

#### PRODUCTION OF FRUIT BODIES IN CULTURE

Whereas the addition of filter paper as a source of cellulose to the special medium referred to above induced abundant normal fruiting of *C. stercoreus* (1, 2), this procedure failed to cause the

<sup>2</sup> Culture No. 9 was eliminated from the series when it failed to continue growth after two transfers.



FIGS. 1-2. *Cyathus vernicosus*.

mycelia of *C. vernicosus* to fruit. Even the development of knots on the mycelium that indicates the beginning of fruit body formation took place only on three cultures that were six weeks old and none of the knots continued to grow.

Cultures were then transferred to sterilized mixtures of old leaves, rotting wood, etc., following Miss Walker's (5) suggestion, but in no instance did fruit bodies appear on any culture although some of these were kept for three months.

Finally it was decided to resort to the use of soil. Mycelium (and agar medium) from five slants in flasks, each culture a month old, was placed in a clean 8 in. flower pot. The culture material was then covered to a depth of one inch with a sifted sterilized loam mixture and the soil was pressed down gently.

One week later, mycelial strands appeared on the surface of the soil and a few fruit body rudiments were visible. By the end of another week, seventy fruit bodies had developed on the culture, all of which opened normally in a few days (FIGS. 1, 2).

Regarding this rapid development of fruit bodies after the addition of soil, it seems unlikely that the soil could supply any nutritional deficiency which could induce fruiting so soon after application. It appears more probable that aeration (texture of the medium, etc.) was not properly provided by the agar slants but was provided by the loose covering of soil. To date, several other cultures of *C. vernicosus* have been induced to fruit in this way, but other methods have proven unsuccessful.

Although several diploid mycelia, each representing combinations of different haploid mycelia, have been fruited, there is little variation in the morphology of the fruit bodies: nothing comparable to the extreme variability characteristic of *C. stercoreus* fruit bodies has been observed.

Most detail concerning the morphology of the fruit bodies is being reserved for future publication. However, because the photographs illustrate two noteworthy features of this species, attention may be drawn briefly to these. It is not generally recognized that fruit bodies of *C. vernicosus* develop a basal mass of hyphae (the so-called "emplacement") comparable with the large and conspicuous ball found at the base of the fruit body of such species as *C. striatus* and *C. stercoreus*. In *C. vernicosus* this

emplacement develops early and may be seen as a mycelial mat around the base of a young fruit body (FIG. 1). As development proceeds, soil becomes incorporated into the emplacement so that its size and full extent are appreciated only when soil is lifted from below the base of the cup.

The epiphragm or covering over the mouth of the unopened fruit body usually ruptures by an irregular tear across the diameter in *C. striatus* and *C. stercoreus*. The epiphragm of all specimens of *C. vernicosus* developed in the writer's cultures seemed to rupture in a circumscissile manner, the epiphragm withdrawing as a shrunken disk to one side of the peridium (FIG. 2).

#### SUMMARY

1. Basidiospores of *Cyathus vernicosus* were germinated one year after collection by subjecting them to a temperature of 40° C. for 48 hrs. in distilled water suspension.

2. Sixty single-spore mycelia were cultured, of which 29 were used in a study of heterothallism.

3. Single-spore mycelia are haploid. The mycelia are quite uniformly white and fluffy, an occasional one showing grey-brown coloration.

4. When paired, haploid mycelia fall into four mating-type groups with uneven distribution of mycelia in the groups. The fungus is heterothallic and tetrapolar.

5. Diploid hyphae bear clamp connections and tend to become aggregated into cords upon which fruit body rudiments arise.

6. Diploid mycelia were induced to fruit only by covering cultures on agar slants with an inch of sterile soil.

7. Each fruit body of *C. vernicosus* has an "emplacement" or mass of basal hyphae which becomes compacted into a solid ball within the soil. This structure is similar to the emplacements of *C. striatus* and *C. stercoreus*.

8. The epiphragm of *C. vernicosus* ruptures most frequently in a circumscissile manner and withdraws to one side of the cup as a shrunken disk.

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## DESCRIPTIONS OF ILLUSTRATIONS

FIG. 1. Young unopened fruit bodies of *Cyathus vernicosus* developed on an agar culture which had been covered two weeks before by one inch of sterile soil. Two young specimens in the lower right show the early development of the basal emplacement hyphae.  $\times 2$ .

FIG. 2. Fruit bodies of *Cyathus vernicosus* a few hours after they had opened. The epiphragm in the largest specimen had withdrawn to the side of the mouth where it remained as a shrunken disk. As specimens get older, the mouth tends to flare outward more than in these young specimens.  $\times 2$ .

## STUDIES IN THE GENUS OTIDEA \*

BESSIE B. KANOUSE

(WITH 21 FIGURES)

During the collecting season of 1948, from late June to October, the University of Michigan maintained a botanical expedition in Mt. Rainier National Park, Washington. Dr. A. H. Smith who conducted the survey was assisted by Henry A. Imshaug and Emory G. Simmons. Dr. D. E. Stuntz of the Department of Botany, University of Washington, joined the group in July. They obtained abundant collections of *Otidea* species which, with the collections in the University of Michigan Herbarium, form the basis of this investigation. The writer recognizes ten species and three varieties. This number materially exceeds the number in previous published reports for North America. Seaver (1928) reported three under the name *Scodellina*. One new species, *O. rainierensis*, and one new variety, *O. alutacea* var. *microspora*, are described from the Mt. Rainier collections and one new species, *O. Kauffmanii*, is named from Michigan material. The types of new species described here are deposited in the University Herbarium of the University of Michigan.

The genus *Otidea* was established by Fuckel (1869-1870) for *Peziza leporina* Pers. ex Fr., *P. onotica* Fr., *P. cochleata* L., and *P. abietina* Pers. The principal diagnostic character by which species of *Otidea* differ from those in *Peziza* is the presence of a split in the apothecium. Fuckel (l.c.) in his diagnosis of the genus described the paraphyses as "filiform subclavate" although he included *O. leporina* and *O. onotica* in which the paraphyses are hooked and not subclavate. Since the genus was established, several species which have filiform or filiform-subclavate paraphyses have been described for it. Boudier (1885) considered the straight paraphyses as distinctive and established the genus *Wynnella* based in part on such paraphyses. *O. auricula* Schaeff. was

\* Papers from the Herbarium of the University of Michigan.



made the type of *Wynnella*. Rehm (1887-1896) reduced this genus to subgeneric rank. The writer does not regard *Wynnella* as sufficiently different from *Otidea* to consider it as a genus.

The paraphyses in the two new species described in this paper exhibit a third type for the genus. In both of these they are filiform and the apices are expanded into broadly clavate, pyri-form or globose to subglobose heads. No previously described species of *Otidea* with this type of paraphysis is known to the writer. *O. fibrillosa* (Currey) Mass. was so described, but the fungus is not an *Otidea*. The spores are described as eguttulate, and the exterior of the apothecia as tomentose. As illustrated by Cooke (1879) the apothecia are not split. Our species are obviously not to be considered *O. fibrillosa*. Besides the split apothecia other characters that *Otidea* species have in common are: elliptical biguttulate (rarely uniguttulate) spores, absence of blue coloration in iodine solution, and the prosenchymatic structure of the hypothecium. The excipular layer shows variation but no more than might be expected as differences at the species level. In general this layer is composed of hyphae which are divided into cells so as to give a pseudoparenchymatic appearance. The cells are subglobose, hexagonal to long cylindrical, and exhibit many irregularities of shape and size. This layer may be relatively thick—up to 300  $\mu$ , or as narrow as 50  $\mu$ . It is yellowish to brownish yellow in color. The transition from the hypothecial layer is usually gradual but it may be sharply differentiated, as it is in *O. auricula*. The outermost layer in some species is fairly even, as in *O. Cantharella* v. *minor* Boud., but in most species the hyphal ends are gathered up into small pyramidal aggregations frequently with short protruding chains of from three to six cells. Such chains are found in connection with the aggregations of hyphae or they may arise from a surface that does not produce the conspicuous bunches of cells. The surface cells are not sufficiently developed to produce more than a very slight tomentosity on the cup proper. The basal portion of the cup and the stipe may be definitely tomentose. In *O. auricula* as represented in the North American collection cited in this paper, the outermost layer is a definite palisade layer of elongate cells rounded at their apices (FIG. 7). Such a distinct palisade layer has not been found

in other species studied by the author nor has reference to it been seen in the literature except in Massee's description of *O. neglecta*. The reader is referred to the remarks concerning this situation in the discussion following *O. auricula*. In *O. grandis* and *O. Smithii* there exists a condition that is peculiar to these species. The excipular layer is covered with minute, subglobose granules golden brown in color. They give the excipular cells a scurfy appearance and emphasize the brown color, and, in *O. grandis*, the mealy texture of the outside of the apothecia. In a water mount they become detached easily. Boudier (1905-1910) illustrated them for *O. umbrina*, but referred to them only in the description of the plate. They were found in all of the collections of *O. Smithii* and *O. grandis* examined by the author.

#### OTIDEA (Fr.) Fuckel

Apothecia sessile to stipitate, gregarious, often cespitose, occasionally fused at their bases, size varying, from 1 cm. to 10 cm. in height, elongate to ear-shaped or truncate, split to the base on one side, glabrous to furfuraceous, hypothecium prosenchymatic, exciple pseudoparenchymatic; asci cylindrical, 8-spored; spores usually smooth, biguttulate (infrequently uniguttulate); paraphyses filiform and frequently branched below, apices straight, bent, hooked, clavate, or globose; no blue color reaction in iodine.

Type of the genus: *Otidea leporina* (Fr.) Fuckel.

#### KEY TO SPECIES

1. Paraphyses hooked or bent at their apices.....2
1. Paraphyses not hooked or bent at their apices.....8
2. Apothecia typically ear- or spoon-shaped.....3
2. Apothecia truncate, not ear-shaped.....6
3. Apothecia large, deep vinaceous brown, concolorous.....*O. Smithii*
3. Apothecia some shade of yellow or yellow-brown.....4
4. Apothecia bright yellow with rosy tints to the hymenium; spores 12-14 × 6-7 (8) μ.....*O. onotica*
4. Apothecia lacking rosy tints in hymenium.....5
5. Apothecia medium to large, clear yellow; spores 10-12 (13) × 5-6 μ....  
*O. concinna*
5. Apothecia medium sized, dull yellowish brown; spores 12-14 × 6-8 μ....  
*O. leporina* v. *typica*
5. As above but spores 8-11 × 5-6 μ.....*O. leporina* v. *minor*

6. Apothecia usually densely cespitose, medium to large, alutaceous outside, wood-brown inside; spores  $14-16 \times 7-9 \mu$ .....*O. alutacea* v. *typica*
6. As above but spores  $9-11 \times 5.5-6.5 \mu$ .....*O. alutacea* v. *microspora*
6. Apothecia not alutaceous in color.....7
7. Apothecia small to medium, exterior dark brown, mealy; spores  $14-17 \times 6-7 \mu$ .....*O. grandis*
7. Apothecia small, dull brownish yellow; spores  $10-11$  (12)  $\times 6-7 \mu$ .....*O. Cantharella* v. *minor*
8. Paraphyses not enlarged at apices; apothecia large, ear-shaped, red-brown, mahogany outside, nearly concolorous within; spores  $23-25 \times 12-16 \mu$ ...*O. auricula*
8. Paraphyses with apices enlarged.....9
9. Paraphyses with broadly clavate to subglobose heads.....10
9. Paraphyses with numerous notched branchlets near apices..*O. abietina*
10. Apothecia large, wood-brown outside, drab gray inside.....*O. rainierensis* sp. nov.
10. Apothecia small, yellowish tan to yellowish buff, concolorous.....*O. Kauffmanii* sp. nov.

OTIDEA LEPORINA (Fr.) Fuck. var. TYPICA (FIGS. 1, 2).

Apothecia gregarious or cespitose, usually elongate-ear-shaped, split to the base on the short side, 1-4 cm. in height, 1-3 cm. in width, narrowed below into a stipe variable in length up to 6 mm. long, outside "hazel" (R.) \* to "cinnamon rufus" (dry), inside "wood brown," "avellaneous" to "Sabal brown" (dry), stipe creamy white; hypothecium composed of hyaline hyphae interwoven; excipular layer thin ( $50-75 \mu$ ), composed of irregularly arranged subglobose to polygonal cells yellowish in color, the outermost layer giving rise to short chains and aggregations of cells; asci cylindrical,  $140-170 \times 10-12 \mu$ , 8-spored, not turning blue in iodine; spores elliptical, smooth, slightly colored yellowish,  $12-14 \times 6-8 \mu$ , biguttulate; paraphyses filiform, hyaline, apices slightly thickened, hooked.

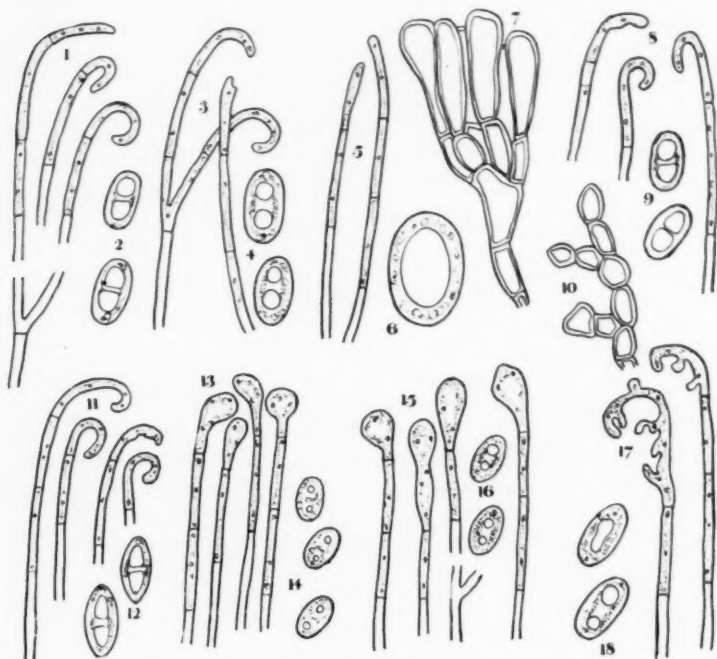
HABITAT: On ground.

DISTRIBUTION: Colorado, Maryland, New York, Oregon, Washington.

MATERIAL EXAMINED: Rehm, Ascomyceten 1627a, 1627b; C. A. Brown, Lake Quinault, Wash., Oct. 11 and Oct. 13, 1925; F. B. Cotner, Tolland, Colo., Aug. 27 and Aug. 28, 1920; J. B. Flett, Bremerton, Wash., Oct. 26, 1942; W. Haydon, Marshfield, Ore., Oct. 12, 1914; C. H. Kauffman and E. B. Mains, Lake Placid, New York, Sept. 10, 1914; C. H. Kauffman, Lake Cushman, Wash., Oct. 2, 1915; Cabin John, Md., Aug. 22, 1919;

\* Ridgway, R., 1912. Color Standards and Color Nomenclature, Washington, D. C.

Tolland, Colo., Aug. 27, 1920; Lake Quinault, Wash., Oct. 11 and Oct. 13, 1925; Takilma, Ore., Dec. 10, 1925; E. G. Simmons, Longmire, Wash., Sept. 4, 1948, 2172; A. H. Smith, Lake Crescent, Wash., Oct. 28, 1935, 3380; Lake Tahkenitch, Ore., Nov. 21, 1935, 3585; Lower Nisqually River, Wash., Sept. 2, 1948, 30888, Nancy Jane Smith, Longmire, Wash., Aug. 26, 1948 (A. H. Smith 30664); L. E. Wehmeyer, Mt. Hood, Ore., Oct. 15, 1922.



FIGS. 1-18. Microscopic characters in *Otidea*.

*OTIDEA LEPORINA* (Fr.) Fuck. var. *MINOR* (Rehm) Sacc. Syll. Fung. 8: 94. 1889.

Like var. *typica* except that the asci and spores are smaller. The spores measure  $8-11 \times 5-6 \mu$ .

HABITAT: On ground.

DISTRIBUTION: California, Michigan, New York, Oregon, Washington.

MATERIAL EXAMINED: C. H. Kauffman, Takilma, Ore., Nov. 29, and Dec. 10, 1925; C. H. Kauffman and Ethel Taylor, Marquette, Mich., Aug. 27, 1909; C. H. Kauffman and E. B. Mains, Chelsea, Mich., Aug. 2, 1915;

C. H. Kauffman and C. A. Brown, Takilma, Ore., Dec. 7 and Dec. 10, 1925; E. B. Mains, Rock River, Mich., Aug. 20, 1932, 32-177; Baker Lake, Wash., Aug. 31, 1941, 6180; A. H. Smith, Warrensburg, N. Y., Sept. 14, 1934, 1002; Crescent Beach, Wash., Sept. 24, 1935, 2594; Trinidad, Calif., Nov. 30, 1935, 3690; Whitmore Lake, Mich., Sept. 26, 1936, 4929; George Reserve, Pinckney, Mich., July 7, 1937, 6454; Lower Tahoma Creek, Wash., Aug. 20, 1948, 30372; L. E. Wehmeyer, Mt. Hood, Ore., Sept. 28, and Oct. 1922.

*OTIDEA ONOTICA* (Fr.) Fuck. Symb. Myc. 329. 1869-70. (Figs. 10, 19).

Apothecia gregarious, often cespitose, substipitate to stipitate, elongate, typically spoon- or ear-shaped, margin involute, divided to the base on one side, arising from a mass of debris held together with mycelium, base white tomentose, 6-10 cm. in height, 5-6 cm. in width (wider if expanded), externally "ochraceous



Photo A. H. Smith.

FIG. 19. *Otidea onotica*.  $\times \frac{1}{2}$ .

orange," "cinnamon," "orange buff" (dry), interior "pinkish cinnamon," "ochraceous buff" to "apricot buff" with tints of rose; hypothecium composed of hyaline hyphae densely interwoven; excipular layer  $50\mu$  in thickness, composed of large cell-like hyphae from the outermost layer of which arise chains and irregular groups of cells; asci cylindrical,  $160-200 \times 9-11\mu$ , not turning blue in iodine; spores elliptical, obliquely uniseriate, hyaline or colored faintly yellowish, smooth, biguttulate,  $12-14 \times$

6-7 (8)  $\mu$ ; paraphyses filiform, usually strongly hooked, frequently forked below.

HABITAT: On the ground, usually in conifer forests.

DISTRIBUTION: California, Michigan, New Hampshire, Oregon, Washington.

DISCUSSION: The apothecia are larger and more brightly colored than in *O. leporina*. Since the time of Fries mention has been made of the rosy color present in the inside of the cups. It is strongly indicated even in dry specimens. The depth of color frequently approaches "zinc-orange." *O. leporina*, with which it has been confused, is duller in color and seldom approaches the size of *O. onotica*.

MATERIAL EXAMINED: H. A. Imshaug, Nisqually River, Wash., Aug. 30, 1948, 2116; C. H. Kauffman and C. A. Brown, Takilma, Ore., Dec. 2, 1925; E. B. Mains, Randolph, N. H., Aug. 19, 1938, 4205; Sept. 5, 1937, 4180; E. G. Simmons, Lower Tahoma, Wash., Sept. 5, 1948, 2178; A. H. Smith, LakeTahkenitch, Ore., Nov. 10, 1935, 3414; Belknap Springs, Ore., Oct. 23, 1937, 8127; Milford, Mich., July 2, 1940, 15166; Chelsea, Mich., July 31, 1937, 6719; Oregon Caves, Ore., Dec. 1, 1937, 9322; Lower Tahoma Creek, Wash., Aug. 22, 30441, Aug. 25, 30579, Aug. 27, 30674, Sept. 8, 1948, 30990, Sept. 20, 1948, 31544; Helen Smith, California Line, Nov. 20, 1937; A. H. Smith, Smith River, Calif., Oct. 16, 1937, 8940; L. E. Wehmeyer, Oct. 13, 1922.

*Otidea concinna* (Pers. ex Fr.) Sacc. Syll. 8: 96. 1889.

Apothecia solitary to cespitose, truncate, strongly folded into convolutions, arising from a stout stem-like base, 2-3 cm. high, 3-4 cm. wide, color "pinkish cinnamon" to "Sabal brown" (dry) with a suggestion of yellow (said to be clear yellow when fresh), concolorous, whitish tomentose below; hypothecium composed of coarse, loosely woven hyaline hyphae; excipular layer narrow, pseudoparenchymatic, outer surface of large cell-like segments irregularly arranged, chains of cells present; asci cylindrical, 125-175  $\times$  8-10  $\mu$ , 8-spored, not turning blue in iodine; spores elliptical, 10-12 (13)  $\times$  5-6  $\mu$  slightly colored yellowish, smooth, biguttulate; paraphyses filiform, sometimes forked below, apices hooked or bent.

HABITAT: On the ground.

DISTRIBUTION: Idaho, Washington, Sweden.

DISCUSSION: This species is represented for North America in the University of Michigan Herbarium by three collections. These

collections and that of Rehm: Ascomyceten No. 1628 are indistinguishable in the dry condition as well as in their microscopical characters. The cups are much folded. One cup in the Idaho collection was measured after being soaked in water and the ruffled edge measured 20 cm. in circumference. Letellier (1829-1842) has an excellent illustration of this fungus.

MATERIAL EXAMINED: Rehm: Ascomyceten 1628 Sweden. Mycobiota of North America, Wm. B. Cooke, Latah Co., Idaho, 285 (distributed as *O. leporina*); H. A. Imshaug, Nisqually River, Wash., Aug. 30, 1948, 2127; E. G. Simmons, Fish Creek, Mt. Rainier Nat. Park, Wash., Aug. 25, 1948, 2067.

OTIDEA CANTHARELLA var. MINOR Boud. Icon. Myc. 4, p. 181. 1905-1910. Vol. 2, pl. 326.

Apothecia solitary to gregarious, small, 1-1.5 cm. in height, 1-2.5 cm. broad, truncate, split on the short side to the base, edges of split enrolled, pale yellow outside, concolorous, drying "ochraceous buff" to "light ochraceous buff," substipitate, creamy white below (dry); hypothecium composed of hyaline hyphae densely interwoven; excipulum pseudoparenchymatic, cell-like hyphae thick-walled, yellowish, forming a fairly regular outer layer, not arranged in aggregations, palisades or chains; asci cylindrical, 140-160  $\times$  10-12  $\mu$ , 8-spored, not turning blue in iodine; spores elliptical, smooth, biguttulate, 10-11 (12)  $\times$  6-7  $\mu$ , obliquely arranged in the asci; paraphyses filiform, hyaline, septate, branched below, apices bent or hooked, slightly thickened above and reaching 3  $\mu$  in width.

HABITAT: On the ground.

DISTRIBUTION: Colorado, Washington.

MATERIAL EXAMINED: E. B. Mains, Wild Basin, Rocky Mountain National Park, Colo., Sept. 1, 1940, 5270; A. H. Smith, Lower Tahoma Creek, Wash., Sept. 8, 1948, 31033.

OTIDEA ALUTACEA (Fr.) Bres. var. TYPICA (FIGS. 3-4, 20).

Apothecia cespitose, frequently in large dense clusters, irregularly contorted, bases sometimes joined, infrequently solitary, truncate, sub-sessile or short stipitate, 2-6 cm. in height, 2-4 cm. in width, smooth, glabrous, drying wrinkled, exterior "tawny olive," "pinkish buff" or "cinnamon buff" to "clay color," "wood brown" (dry); hymenium "avellaneous" to "wood brown" (fresh), fragile; hypothecium composed of hyaline hyphae densely interwoven;



excipular layer pseudoparenchymatic, up to  $200\mu$  thick, cell-like unit subglobose, yellowish, ending in a narrow marginal layer of irregular chains and loosely arranged groups of hyphal segments; asci cylindrical,  $150-200$  ( $250$ )  $\times 8-10\mu$ , not turning blue in iodine; spores narrowly elliptical, smooth,  $14-16 \times 7-9\mu$ , biguttulate, slightly colored yellowish, uniseriate or obliquely arranged in the asci; paraphyses filiform, occasionally branched below one or two times, septate, hyaline, apices hooked.

HABITAT: On ground in coniferous forests.

DISTRIBUTION: California, Washington.

MATERIAL EXAMINED: Mycobiota of North America, Wm. Bridge Cooke 284 (distributed as *Otidea grandis*); H. A. Imshaug, Lower Tahoma Creek, Wash., 759, 830, 849, 859, 965, 1124, 1125, 1225; E. G. Simmons, Longmire, Wash., July 28, 1948, 1722, Aug. 30, 1948, 2106, 2108; A. H. Smith, Olympic Nat. Park, Wash., Sept. 27, 1941, 17338 (reported by the writer (1947) provisionally as *O. felina*.); Lower Tahoma Creek, Wash., July 31 to Aug. 23, 1948, 29284, 29295, 29299, 29302, 29411, 29416, 29418, 29507, 29538, 29547, 29595, 29615, 29672, 29714, 29840, 29937, 30099, 30194, 30275, 30444, 30555, 31008, 31168; Paul Rea, Santa Barbara Co., Calif., Dec. 31, 1941, 1081.

***Otidea alutacea* var. *microspora* var. nov.**

Apothecia solitaria aut caespitosa 5-8 cm. alta, truncata, pallide hyalino-flava, subtus albida, sicco pallide lutea usque roseo-lutea; sporis  $9-10 \times$

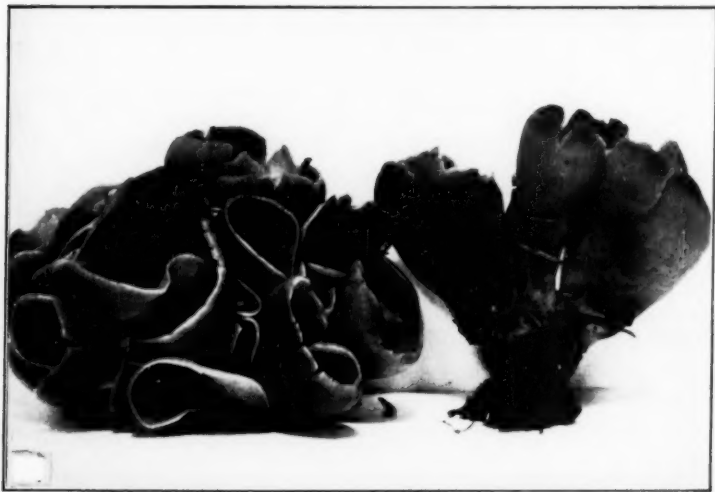


Photo A. H. Smith.

FIG. 20. *Otidea alutacea* var. *typica*.  $\times \frac{1}{2}$ .



5.5–6.5 (7)  $\mu$ ; hypothecio, excipulo, et paraphysibus varietatis typicae similibus.

Ad humum, Crescent City, Calif., 3 Dec. 1937. A. H. Smith. No. 9351, Typus.

Apothecia solitary or cespitose, 5–8 cm. in height, truncate, pale clear yellow (fresh), whitish below, drying "pale buff" to "pinkish buff"; asci 175–200  $\times$  7–10  $\mu$ , frequently with long rooting base, spores 9–10  $\times$  5.5–6.5  $\mu$ ; hypothecium thick, up to 350  $\mu$ ; exciple thin; paraphyses with narrowly clavate apices, straight or hooked.

HABITAT: On ground.

DISTRIBUTION: California, Washington.

DISCUSSION: The differences between var. *typica* and var. *microspora* lie in the spore size and in the color of the apothecia. In var. *microspora* the color is paler and more yellow, and the spores are smaller.

MATERIAL EXAMINED: Olympic Hot Springs, Olympic Nat. Park, Wash., Oct. 8, 1941, A. H. Smith 17699, **type**; reported by the writer (1947) provisionally as *O. felina* (Pers. ex Fr.) sensu Bres. A. H. Smith, Crescent City, Calif., Dec. 3, 1937, 9351; Lower Tahoma Creek, Wash., Aug. 23, 1948, 30502.

OTIDEA AURICULA (Cke.) Mass. Grev. 21: 65. 1894 (Figs. 5, 6, 7, 21).

Apothecia gregarious or solitary, narrowly elongate, ear-shaped, split on one side to the base, edges enrolled, stem-like base short, usually grooved, becoming horny when dry, 3–7 cm. in height, 1–2 cm. in width (3–4 cm. if flattened out), smooth, bay to chestnut brown shading to "clay color" at the base, margin sometimes "Sayal brown," inside darker, when dry dull purplish brown inside and outside; hypothecium composed of hyaline hyphae densely interwoven; excipular layer composed of pseudoparenchymatic hyphae, 100  $\mu$  in thickness, the outermost hyphal segments arranged in a definite palisade layer, elongated, ends rounded at the apices, containing brown coloring matter, color soluble in water; asci cylindrical, 300–400  $\times$  15–18  $\mu$ , 8-spored, not turning blue in iodine; spores hyaline, smooth, containing one large central oil drop, 22–25  $\times$  12–16  $\mu$ , uniseriate; paraphyses filiform, becoming clavate at the apices, 6  $\mu$  in diameter, containing brown coloring matter.

HABITAT: On the ground.

DISTRIBUTION: Michigan, Montana.

DISCUSSION: This species is not to be confused with a similar fungus which is white outside instead of brown. Massee has named the fungus with the white exterior *O. neglecta* Massee. The uniform yellowish brown color of the apothecia as observed in our collection is in accord with the interpretation of *O. auricula* sensu Massee. He based his concept of the species in part on the statement made by Schaeffer (1763) who described and illustrated a fungus which Massee interpreted as *O. auricula*. Rehm (1887-1896), Boudier (1905-1910), and Bresadola apply the specific



Photo C. H. Kauffman.

FIG. 21. *Otidea auricula*.  $\times \frac{1}{2}$ .

name *O. auricula* to fungi having a whitish exterior. Both Boudier and Bresadola have illustrated such apothecia. Massee stated that the hyphal structures of the two species were different; that the exciple in *O. auricula* was parenchymatic while in *O. neglecta* the outermost cells were arranged parallel. Our North American collections have the dark color accorded to *O. auricula* (Cke.) Massee but have a palisade arrangement of the excipular layer similar to what Massee (l.c.) reported for *O. neglecta*.\*

\* Since this paper went to press the writer has, through the kindness of Sir Edward Salisbury, seen specimens of *O. auricula* and *O. neglecta* from Kew

His illustration shows the palisade layer to be composed of parallel chains, which is unlike the palisade in the American specimens of *O. auricula*. In view of the condition found in the American material, one wonders whether or not Massee's conclusions were an altogether correct interpretation. The spores as reported in the literature are given as large,  $22-25 \times 12-16 \mu$ . The paraphyses are straight and filiform. In these respects our specimens conform to the European *O. auricula*. Boudier placed the fungus in *Wynnella*.

MATERIAL EXAMINED: G. B. Cummins, Echo Lake, Flathead Nat. Forest, Montana, July 23, 25, and 31, 1928; F. J. Hermann, Big Stone Bay, Emmet Co., Mich., June 13, 1936.

OTIDEA SMITHII Kanouse, Pap. Mich. Acad. Sci. Arts & Letters 24: 28. 1939 (Figs. 8, 9).

Apothecia solitary or cespitose, arising from a large solid foot-like base composed of mycelium intermixed with soil, elongate, ear-shaped, fragile when dry, split on one side, up to 8 cm. in height, outside of apothecium "Van Dyke brown," "Rood's brown" shading to "vinaceous" toward base, inside "wood brown," drying "vinaceous-buff"; hypothecium, composed of hyaline, loosely interwoven hyphae; excipular layer narrow, composed of small thick-walled, brown cells loosely and irregularly arranged, at the surface bunched in shallow piles formed from groupings of 3-5-celled chains, surface cells covered with small granules golden brown in color; asci cylindrical,  $100-160 \times 12-14 \mu$ , 8-spored, not turning blue in iodine; spores hyaline or faintly colored yellowish, narrowly elliptical, smooth, biguttulate,  $10-12 (14) \times 6-7 \mu$ ; paraphyses with large hooked or bent apices, hooks sometimes ornamented by small, irregular protuberances.

HABITAT: On soil under conifers.

MATERIAL EXAMINED: E. G. Simmons, Lower Tahoma Creek, Wash., Sept. 5, 1948, 2180, 2182; A. H. Smith, Crescent City, Calif., Nov. 18, 1937, 8843, Dec. 3, 1937, 9340; Lower Tahoma Creek, Wash., Sept. 28, 1948, 30994, 30995.

Herbarium presumably those seen by Massee. The writer could find no appreciable difference in the specimens examined. They appeared to have a pallisade arrangement of the excipular cells. No specimens retained any appearance of white exteriors.

OTIDEA GRANDIS (Pers.) Rehm. 1887-1896. p. 1023. 1894 (Figs. 11, 12).

Apothecia solitary or cespitose, 1-2 cm. high, 1-4 cm. broad, fleshy-leathery, drying horny, stipitate, truncate, expanded, split to base, edges of split and top of apothecium deeply enrolled when dry; outside "Van Dyke brown," "liver brown" mealy-scurfy, hymenium pale, "vinaceous fawn," "ochraceous tawny" (dry), frequently with patches of red-orange, the orange red color conspicuous when the cups are revived in water, stipe thick, up to 1 cm. long, yellowish in color; hypothecium composed of coarse, hyaline, septate hyphae, loosely interwoven; excipular layer sharply differentiated from the hypothecial layer, composed of thick-walled hyphal segments that resemble small subglobose or irregularly hexagonal cells, walls dark brown, 15-20  $\mu$  in diameter, outermost layer of excipular segments covered with minute granules which are subglobose, golden brown in color, becoming easily detached; outside drying mealy, rough; asci cylindrical, 185-200  $\times$  10-12  $\mu$ , 8-spored, uniseriate, not turning blue in iodine, collapsing when empty, spores long elliptical to slightly fusoid, 14-17  $\times$  6-7  $\mu$ , biguttulate, outer wall smooth, inner wall becoming minutely roughened in age, occasionally biseriate in upper part of asci; paraphyses filiform, frequently forked below, apices strongly hooked, sometimes clavate, 4-5  $\mu$  in diameter.

HABITAT: On the ground.

DISTRIBUTION: New York, Nova Scotia, Michigan, Europe.

DISCUSSION: Rehm remarked upon the lack of the green color in *O. grandis*. Boudier (1905-1910) and Bresadola (1932) both illustrate the species as having olive green shades in the exterior of the cups. Our North American collections as well as the European collection represented by Sydow, Mycotheca Germanica No. 2354 lack green color in the dry condition; they are uniformly liver brown. While no color notes are available on fresh material, it is doubtful whether or not any distinct olive green color was ever present in the outside of the apothecia. The hymenium (dry) is lighter in color but when soaked in water developed some shade of orange, frequently a bright orange-red. The apothecia in our material are all more shallow than indicated by Boudier's illustration. In microscopic characters, however, the specimens conform with Rehm's description of the species. The spores are long-elliptical and tend to be narrow at the ends.

The outer wall is smooth but in age the inner wall is minutely roughened. This character is apparent with the aid of an oil immersion lens. The granules on the excipular segments add to the intensity of the brown color of the outside of the apothecia. They are readily washed off in a water mount. Boudier (1905-1910) illustrated them for *O. umbrina*, but no other investigator seems to have observed them for they have not been mentioned elsewhere. They make a useful diagnostic character for these species.

MATERIAL EXAMINED: Ellis and Everhart, North American Fungi 1778, second series, as *Peziza onotica* Pers.; Sydow, Mycotheca Germanica 2354; C. H. Kauffman, Caroline, N. Y., Sept. 6, 1903; Lake Woods, Mich., Aug. 18, 1915; Morten Lange, Burt Lake, Cheboygan Co., Mich., Aug. 4, 1947; E. B. Mains, Deerton, Mich., Sept. 2, 1932, 32-517; Rock River, Mich., Sept. 6, 1932, 32-609; Emerson, Mich., Sept. 2, 1933, 33-580; A. H. Smith, Salmon River, Nova Scotia, Aug. 18, 1931, det. L. E. Wehmeyer (1344) as *O. leporina*; Catlin Lake, N. Y., Aug. 19, 1934, 396; Milford, Mich., July 29, 1937, 6687; Maple River, Cheboygan Co., Mich., July 22, 1947, 25931.

**Otidea Kauffmanii** sp. nov. (FIGS. 13, 14).

Apothecia solitaria usque gregaria, stipitata, 2-3 cm. alta, truncata, 2-4 cm. lata, rupta, "chamois" usque ochracea, sicco roseo-lutea; hymenio cremeo-luteo, sicco roseo-luteo; stipite 5-10 mm. alta, 3-5 mm. crassa; hypothecio prosenchymatico, excipulo pseudoparenchymatico, cellulis superficiei irregularibus; ascis 150-200  $\times$  10-12  $\mu$ , sporis ellipticis, levibus, biguttulatis, 8-10 (12)  $\times$  5-6 (7)  $\mu$ ; paraphysibus hyalinis, saepe subtus ramosis, filiformibus, apicibus subito incrassato, globosis aut clavatis, 6-10  $\mu$  diam.

Ad humum, 18 Julii 1915, Lakeland, Michigan, C. H. Kauffman, **Typus**.

Apothecia solitary to gregarious, stipitate, 2-3 cm. in height, truncate, 2-4 cm. in width, split down the short side of the cup, fleshy, hard when dry, "chamois" to "ochraceous" (fresh), dirty pinkish buff (dry); hymenium "cream buff" (fresh), "pinkish buff" (dry), whitish pubescence on lower part of cup extending into the stipe; stipe 5-10 mm. long, 3-5 mm. thick; hypothecium composed of hyaline hyphae, densely interwoven, excipular layer 100-150  $\mu$  thick, pseudoparenchymatic, forming irregular piles of cells on the outer surface; asci cylindrical, 150-200  $\times$  10-12  $\mu$ , base long, slender, sometimes twisted, 8-spored, not colored blue in iodine; spores elliptical, smooth, biguttulate, faintly colored yellowish, 8-10 (12)  $\times$  5-6 (7)  $\mu$ ; paraphyses flexuous, filiform, hyaline, septate, infrequently branched below, apices enlarged into broadly clavate, pyriform or globose heads 6-8 (10)  $\mu$  diameter, frequently bent (never hooked).

HABITAT: On the ground.

DISTRIBUTION: Michigan.

DISCUSSION: Ample notes were made by Dr. Kauffman on the fresh material of the collection which has been designated as the type. The globose heads of the paraphyses were noted by him in the fresh material. They are also conspicuous in the dry specimens. Paraphyses of this type were also found in *Otidea rainierensis* which is described in this paper. However, the two species are distinct on the basis of size, shape and color of apothecia and also on differences in spore size.

MATERIAL EXAMINED: In low frondose woods, Lakeland, Michigan, July 18, 1915, collected by C. H. Kauffman, **type**. Reported by C. H. Kauffman, Report Michigan Academy of Science 9: 146. 1917, as *Otidea phlebophora* (B. & Br.) Phillips; A. H. Smith and R. J. Porter (Smith 21147), George Reserve, Pinckney, Mich., Oct. 6, 1945; A. H. Smith, Strawberry Lake, Mich., July 19, 1929.

***Otidea rainierensis* sp. nov. (Figs. 15, 16).**

Apothecia solitaria aut gregaria, ex basi stipitosa oriunda, 3-7 cm. alta, 3-5 cm. lata, in siccitate fragilia, extus ochraceo-lutea usque pallide brunnea, intus avellanea usque grisea; hypothecio prosenchymatico, excipulo pseudoparenchymatico, catenis brevibus cellularum praedito; sporis ellipticis, levibus, biguttulatis,  $10-12 \times 6-7$  (8)  $\mu$ ; paraphysibus filiformibus, apicibus subito incrassatis, globosis aut subglobosis aut clavatis 6-8 (10)  $\mu$  diam.

Ad humum sylvaticum. Lower Tahoma Creek, Mt. Rainier National Park, Washington, Aug. 23, 1948. A. H. Smith No. 30553, **Typus**.

Apothecia solitary to gregarious, arising from a short stalk-like base, 3-7 cm. in height, nearly as wide as high, substance thin and fragile when dry, split to the base, edges enrolled, exterior "ochraceous buff," "cinnamon buff" to "wood brown" (dry), inside "avellaneous," "vinaceous buff" to "drab gray" (dry), creamy white toward base, stipe up to 1 cm. in height, tending to be hollow; hypothecium composed of hyaline hyphae loosely interwoven, merging gradually into a shallow excipular layer 50-100  $\mu$  in thickness, exciple composed of large subglobose or elongated cells only faintly colored yellow, irregularly arranged, the outermost layer of which produces a few chains; asci cylindrical,  $140-160 \times 10$   $\mu$ , frequently with a long slender stalk-like base, not turning blue in iodine; spores elliptical, smooth, faintly yellowish, biguttulate,  $10-12 \times 6-7$  (8)  $\mu$ , arranged obliquely in the asci; paraphyses hyaline, septate, very slender, filiform, abruptly thickened at the apices into broadly clavate, pyriform, subglobose to globose heads 6-8 (10)  $\mu$  in diameter.

HABITAT: On humus in woods.

DISTRIBUTION: Washington.

MATERIAL EXAMINED: Lower Tahoma Creek, Mt. Rainier National Park, Wash., Aug. 23, 1948, A. H. Smith 30553, **type**; A. H. Smith, Aug. 22, and Aug. 23, 1948, 30443, 30556; E. G. Simmons, Sept. 5, 1948, 2179.

OTIDEA ABIETINA (Pers. ex Fr.) Fuck. Symb. Myc. 330. 1869-1870 (FIGS. 17, 18).

Apothecia solitary or gregarious, short stipitate, 2-4 cm. broad, 2-3 cm. in height, usually split on one side, truncate, "liver brown" outside, concolorous within, stipe short, arising from a mass of debris bound together with mycelium, whitish tomentose at base; hypothecium composed of coarse hyphae loosely interwoven, excipular layer consisting of large, thick-walled cells hexagonal in shape, the outermost layer of cells smaller in size, and forming a nearly even surface with but few protruding chains of cells; asci cylindrical, 200-250  $\times$  12-15  $\mu$ , 8-spored, not colored blue in iodine; spores elliptical, smooth, faintly colored yellowish, biguttulate, 18-20 (22)  $\times$  10-12  $\mu$ ; paraphyses filiform, forked below, septate, apices bent, enlarged and variously ornamented with proliferations and notches or branches usually on the under side of the bent portion, filled with granules faintly colored yellowish, extending beyond the asci forming a loose tangle.

HABITAT: On ground.

DISCUSSION: *Peziza abietina* Pers. was transferred to the genus *Otidia* by Fuckel. It has since been placed in *Aleuria* by Gillet (1879), in *Discina* by Rehm (1887-1896). Boudier placed it in his genus *Pseudotis*, Bresadola (1932) in *Otidia*, and Seaver (1928) in *Peziza*. These interpretations are indicative of the uncertainty regarding the generic position of the species. The fact that apothecia are sometimes without a split is probably the reason for its being assigned to genera other than *Otidia*. However, there is sufficient proof that the split condition is the more common, and thus it is logical to seek for the species in the genus *Otidia*; therefore a description is included here. That there is no blue coloration in iodine, that the paraphyses are bent, and that the spores are biguttulate, suggest its affinity with species of *Otidia*. It is certain that one would expect to find it listed in *Otidia* whenever cups with true splits were found and the bent paraphyses



would also suggest this relationship. The under side of the bend in the paraphyses is ornamented with notches and short proliferations which give them a distinctive appearance. It is not uncommon to find similar modification in paraphyses in other *Otidea* species but never has the author seen them so profuse or so conspicuous. The paraphyses project beyond the asci and form loose tangles but are not organized into a definite epithelial layer. Boudier (1905-1910) and Bresadola (1932) illustrate them, but the latter's figures show fewer proliferations. The spore size according to most authors is reported as large ( $18-20-26 \times 10-12 \mu$ ). Rehm points out that the specimen cited by Fuckel (No. 1226) which he himself examined is *Peziza badia*; that the spores measured only  $14 \times 7 \mu$ , and are rough. The notched paraphyses, the lack of blue coloration and split apothecia were constant in the collections cited in this study.

MATERIAL EXAMINED: Sydow: Mycotheca Germanica 2540 (*Discina abietina* (Pers.) Rehm). G. B. Cummins, Echo Lake, Montana, July 6, 1928; C. H. Kauffman, Ithaca, N. Y., Aug. 6, 1904; C. H. Kauffman and D. V. Baxter, Tolland, Colo., Sept. 1920; E. B. Mains, Rock River, Mich., Aug. 20, 1932, 32-179; A. H. Smith, Lake Quinalt, Wash., May 17, 1939, 13566; Lake Crescent, Wash., Oct. 28, 1935.

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#### EXPLANATION OF FIGURES

FIG. 1. Paraphyses of *Otidea leporina* var. *typica*; FIG. 2. Spores of *Otidea leporina* var. *typica*; FIG. 3. Paraphyses of *Otidea alutacea* var. *typica*; FIG. 4. Spores of *Otidea alutacea* var. *typica*; FIG. 5. Straight, filiform paraphyses of *Otidea auricula*; FIG. 6. Spore of *Otidea auricula*; FIG. 7. *Otidea auricula*; a fascicle of elongate cells such as form the outermost layer of exciple; FIG. 8. Paraphyses of *Otidea Smithii*; FIG. 9. Spores of *Otidea Smithii*; FIG. 10. Detail showing a branched chain of cells in the exciple of *Otidea onotica*; FIG. 11. Paraphyses of *Otidea grandis*; FIG. 12. Spores of *Otidea grandis*; FIG. 13. Paraphyses of *Otidea Kauffmanii*, showing the abruptly clavate and globose apices; FIG. 14. Spores of *Otidea Kauffmanii*; FIG. 15. Paraphyses of *Otidea rainierensis* showing the clavate to globose apices; FIG. 16. Spores of *Otidea rainierensis*; FIG. 17. Paraphyses of *Otidea abietina* showing the protuberances frequently found; FIG. 18. Spores of *Otidea abietina*.

## A NEW SPECIES OF ACHLYA WITH COILED OOGONIAL STALKS<sup>1</sup>

T. W. JOHNSON, JR.<sup>2</sup>

(WITH 2 FIGURES)

In the course of recent studies on the genus *Aplanes*, a considerable number of soil and water samples have been collected from various localities in Michigan. From two of these collections, made in Washtenaw County, a species of *Achlya* has been recovered which differs markedly from any of the hitherto described species of the genus.

Following recovery from the soil, a single-spore isolate was grown on cornmeal agar, then transferred to boiled, split hempseed, placed in 30 cubic centimeters of sterile, charcoal-filtered, distilled water, and kept at a temperature of 22° C. The description of the species was compiled from such cultures. An examination of the isolate revealed that whereas it resembled, in certain general features, several of the papillate species of *Achlya*, it was actually quite distinct from them. These distinctions are found in the characteristic coiled, spring-like oogonial stalks, the large oospores, the variously-shaped oogonia, and in the sparseness of antheridia. For these reasons, it is considered a new species.

***Achlya spiracaulis*** sp. nov. Myceliis in semine *Cannabis sativae* tenuibus, hyphis ramosis porrectis usque ad 3.0-4.2 cm. in diametrum. Gemmis paucis longis quandoque inaequalibus; sporangiis copiosis, attenuatis sine cylindraciis ad basim saepius latioribus, 280-637  $\mu$  longis, 28-42  $\mu$  in diametrum, plerumque 497-595  $\times$  35-42  $\mu$ , e basi proliferantibus et tunc cymosis; zoosporiis 11.0-14.1  $\mu$  in diametrum, apice dehiscens et in sphaerula dispositis, perraro *in situ* germinantibus. Oogoniis copiosis in ramulis lateralibus longis et spiriformibus aut raro brevibus et rectis, nonnumquam terminalibus in summo hyphae spiriformis, saepius autem. Oogoniis ipsis

<sup>1</sup> Contribution No. 897 from the Department of Botany, University of Michigan.

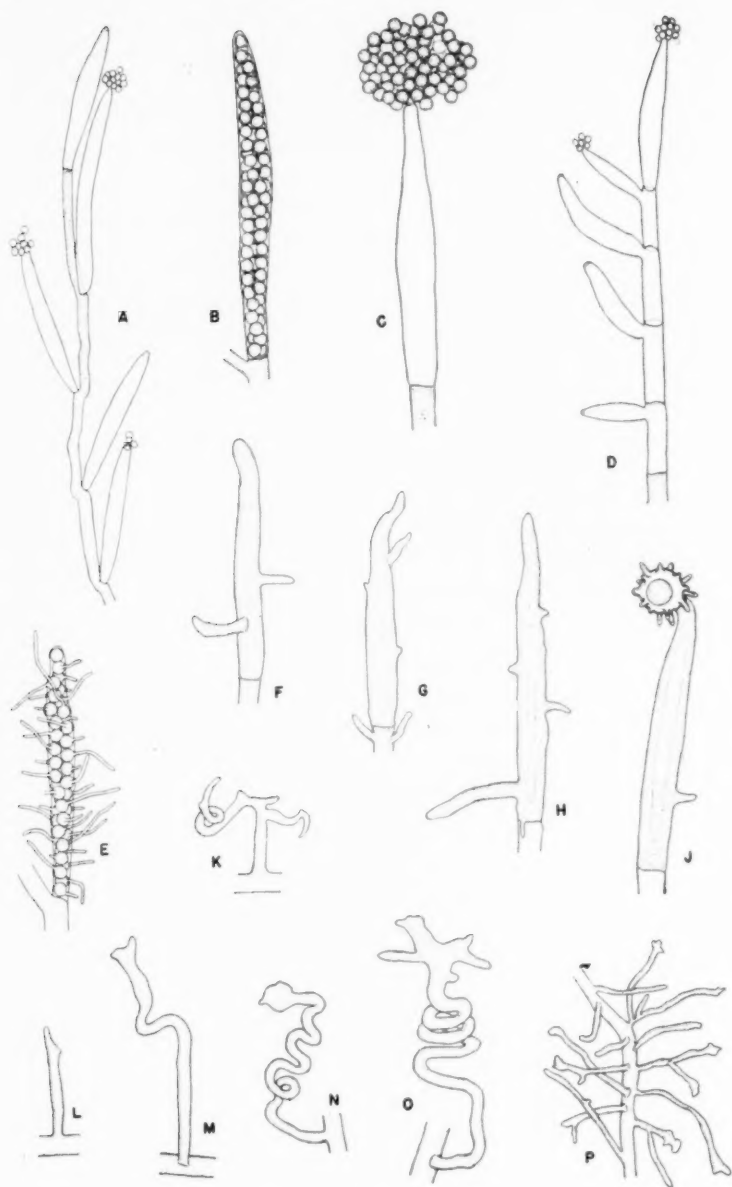
<sup>2</sup> The author wishes to express his sincere gratitude to Professor F. K. Sparrow for his helpful suggestions and criticisms in the preparation of this paper.

44.0–83.6  $\mu$  in diametrum sine spinis, plerumque 60.6–72.5  $\mu$ , aut globosis aut variis, tunica crassa non-punctulata, consista spinis sublongis obtusis. Oosporiis numero 1–12, plerumque 4–8, globosis 13.2–49.5  $\mu$  in diametrum, plerumque 25.0–30.8  $\mu$ , guttulis oleosis centrice dispositis; tunica crassa, hyalini. Antheridiis paucis declinibus aut androgenibus.

Hab: ad terram humosam in ripa rivi intermittentis, Nichols' Arboretum, University of Michigan, Aprilis 4, 1949.

Mycelial growth tenuous, extensive, the colony reaching a diameter of 3.0–4.2 cm. on hempseed; principal hyphae up to 119  $\mu$  in diameter at the base; usually sinuous, moderately branched. Gemmae few, single, terminal, long-tapering and sporangium-like; occasionally quite irregular; upon germination forming thin hyphal branches usually bearing small apical sporangia; rarely germinating to form a terminal oogonium. Sporangia abundant, terminal, long-tapering or cylindrical, usually broadest at the middle or near the base, 280–637  $\mu$  long by 28–42  $\mu$  in diameter, predominantly 497–595  $\times$  35–42  $\mu$ ; secondary sporangia arising by cymose branching or in basipetal succession from below the primary sporangia, in which case including basally a portion of the hypha. Spores at discharge collecting in a hollow sphere at the apical pore, or germinating *in situ* in some secondary sporangia; encysted spores 11.0–14.1  $\mu$  in diameter. Oogonia abundant, borne laterally on very long, tightly or loosely coiled and bent stalks, rarely on short, straight or bent stalks; stalks sometimes branched, and bearing 2–3 oogonia; infrequently terminal, with the hyphal branch also coiled; never observed intercalary; varying greatly in shape, mostly spherical or ovoid, occasionally barrel-shaped, oblong or irregular; wall averaging 1.2  $\mu$  thick, unpitted, densely studded with short or long, round-pointed spines 4.4–30.8  $\mu$  in length, averaging 9.9–14.3  $\mu$ ; oogonia, not including spines, 44.0–83.6  $\mu$ , averaging 60.6–72.5  $\mu$  in diameter; irregular oogonia averaging 104  $\times$  51  $\mu$ . Oospores 1–12, mostly 4–8; 13.2–49.5  $\mu$ , averaging 25.0–30.8  $\mu$  in diameter; centric, with a single layer of oil droplets completely surrounding the protoplasm; typically spherical, but occasionally block-shaped or ellipsoidal from pressure; wall thick, hyaline. Antheridial branches present on 8–12 per cent of the oogonia, about equally androgynous and declinous; antheridia applied by their apices to the oogonia; antheridial cells rarely formed; fertilization tubes not observed.

From soil, along bank of an intermittent stream, Nichols' Arboretum, University of Michigan, April 4, 1949 (**type**), and from soil, along bank of Fleming Creek, near Geddes Road, Washtenaw County, Michigan, May 8, 1949.

FIG. 1. *Achlya spiracaulis*.

Slides of preserved material from the type culture are being deposited in the herbaria of the University of Michigan and the University of Illinois.

*Achlya spiracaulis* has been compared with the original descriptions of all known species of *Achlya*, and although it embodies characteristics of several of these, it differs from them in one outstanding respect: i.e., the production, even under varying environmental conditions, of coiled oogonial stalks. In this feature, the fungus resembles *Achlya contorta* Cornu, but from Cornu's incomplete description and meager illustrations (8), his species possesses smooth-walled oogonia. On the basis of oospore number, and unpitted, spiny oogonial wall, there is a resemblance to *Achlya papillosa* Humphrey (10). However, the sparingly developed sporangia, short oogonial stalks, and the abundant though imperfectly formed antheridia immediately separate *A. papillosa* from the present species.

Coker (3) reports coiling oogonial stalks for *Achlya proliferoides* (3, pl. 36, fig. 6), but because of its smooth oogonial walls, short oogonial stalks, and abundant antheridia, his species is obviously not the Michigan isolate. Coiled oogonial stalks were also reported by Coker (3) for *Achlya Orion*, but these were formed only at a temperature of 36° C. Further, the smooth-walled oogonia and the smaller number of larger oospores also distinguish *A. Orion* from *A. spiracaulis*.

The original description of *Achlya recurva* by Cornu (8) is rather vague. A more complete study was made by Latham (11) of an isolate of *A. recurva* found in North Carolina. *Achlya spiracaulis* evidently resembles Latham's fungus in certain respects, particularly with reference to the atypical, contorted oogonia, the size of encysted zoospores, oospore number, and the scarcity of gemmae. However, because of the coiled oogonial stalks, larger oogonia, larger oospores, and smaller percentage of antheridia, *A. spiracaulis* is distinct from *A. recurva*.

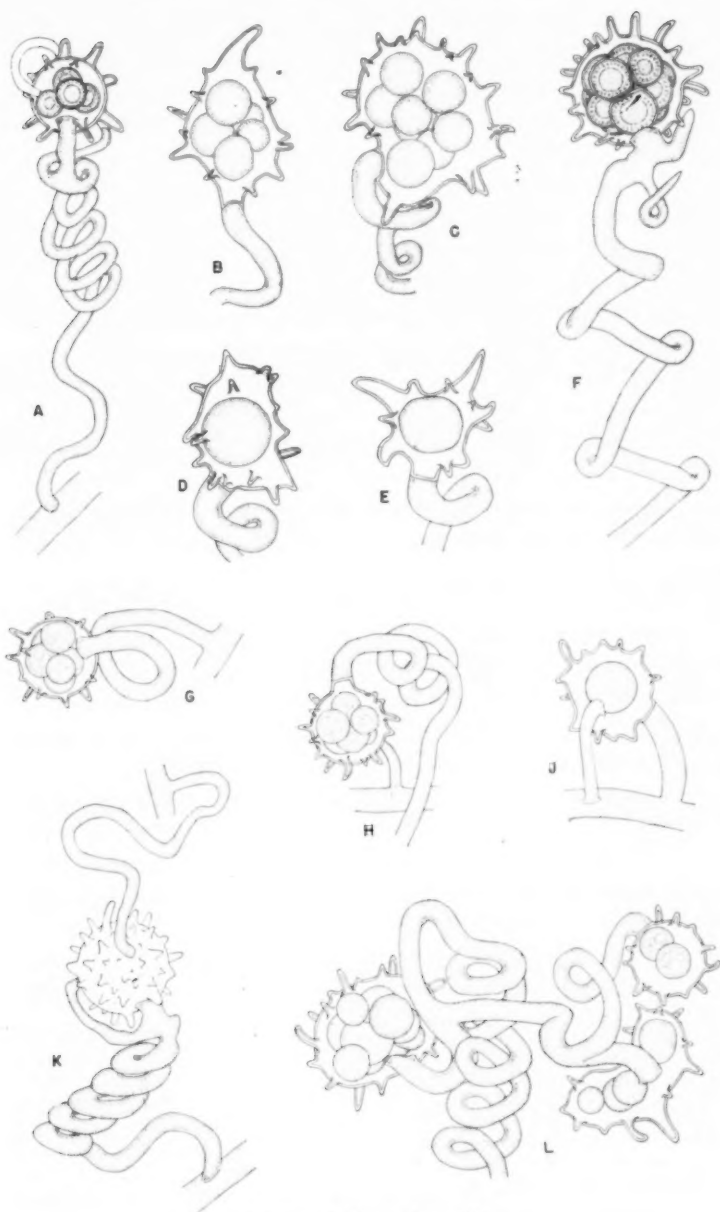
With the exception of *Achlya contorta*, coiled oogonial stalks are not reported for any of the European species of *Achlya*. In addition, other characteristics of these species, such as oospore size and number, size of oogonia, and antheridial characteristics, differentiate them from *A. spiracaulis*.

## OBSERVATIONS

It would be repetitious to record details of sporangial formation and subsequent development and discharge of the zoospores, since, with the possible exception of basipetalous development of secondary sporangia (FIG. 1, D) in older cultures, and germination *in situ* in many of these secondary sporangia (FIG. 1, E), the developmental morphology of the sporangia is that characteristic of the genus *Achlya* (12). Certain points concerning oogonial development in *A. spiracaulis* should, however, be mentioned. As observed in young cultures in sterile, charcoal-filtered, distilled water, the oogonium first appears as a short, lateral protrusion from the main hypha (FIG. 1, L). Over a three or four day period following the appearance of the protrusion, there is a marked elongation into a definite lateral stalk, which, after about three days, begins the characteristic coiling (FIG. 1, M, N). Branching of the oogonial stalk may occur prior to or immediately after coiling (FIG. 1, K). Upon completion of coiling, the tip of each stalk enlarges, and one to several spine-like protrusions make their appearance, which give to the oogonial initial a distinct irregular shape (FIG. 1, O). The tip continues to enlarge, the spines become more numerous, and ultimately the oogonium reaches mature size. It is at about this time that antheridia, if any, are formed. The development of oospores is slow, even in oogonia which are apparently fertilized, since in most cases no oospores are visible for six to eight days after the oogonia reach mature size. Where oogonia are formed terminally, the first indication of their development is again coiling of the stalk, in this instance, the hyphal tip. The subsequent development of terminal oogonia is similar to those formed laterally.

In fifteen- to twenty-day-old cultures, there are occasional instances of oogonia borne on bent or once-coiled stalks (FIG. 2, G, J). Many of the later-formed stalks do not bear oogonia, and in still older cultures may give the hyphae a distinctive, short-branched, bushy or irregular appearance (FIG. 1, P).

Preliminary qualitative studies on the effect of variations in environments other than pure water on *Achlya spiracaulis* have been undertaken. Results would seem to indicate that the distinguishing

FIG. 2. *Achlya spiracaulis*.

coiled-stalk characteristic of the fungus, as well as such features as origin and size of the oogonia, papillations of the oogonial wall, and percentage of antheridia, are consistently stable characteristics.

To determine the characteristics of the fungus when grown in a more natural habitat, a series of 20 single spore isolates were grown in 20 separate samples of water containing leaves and other debris. The water and debris samples were selected from several different sources such as fresh cold water, stagnant cold water, and warm, clear, running water. After the colonies had developed for two weeks in these "natural" habitats, they were observed for possible changes in morphology. In all of these cultures, the fungus retained the characteristics as described. Of interest, nevertheless, is the fact that the appearance of oospores in these cultures was remarkably slow, in most cases not occurring for two to three weeks after the formation of the oogonia.

A more complete study of the effect of varied environments on the morphology of the fungus is to be undertaken at a future date.

#### SUMMARY

A new species of *Achlya*, from Michigan, is described as *Achlya spiracaulis*. The fungus is characterized by long, tightly or loosely coiled oogonial stalks, by which it is easily distinguished from all other species of *Achlya*; large, papillate, spherical to irregular oogonia; large, centric oospores; unpitted oogonial walls, and a low percentage of about equally declinous and androgynous antheridia.

The fungus was grown under several varied environmental conditions (including those simulating natural ones), to induce changes in the distinguishing morphological characteristics, but the results of these preliminary studies show that the coiled oogonial stalks, origin of oogonia, and frequency and type of papillations are consistently stable.

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## DESCRIPTION OF FIGURES

*Achlya spiracaulis*. FIG. 1, *A.* Habit of sporangia, showing cymose branching. *B.* Undischarged sporangium. *C.* Discharged sporangium. *D.* Habit, showing basipetalous development of secondary sporangia. *E.* Secondary sporangium with spores germinating *in situ*. *F, G, H.* Typical gemmae. *J.* Gemma which has germinated to form a small oogonium at its apex. *K.* Young oogonial stalk which shows branching prior to coiling. *L, M, N, O.* Stages in the development of the oogonial stalk, and rudiment of the oogonium. *P.* Cluster of undeveloped oogonial stalks in a thirty-day-old culture. All drawings made with aid of Spencer camera lucida. Figs. *A, D, F, G, H, J,* and *P*,  $\times 170$ ; all others,  $\times 410$ .

FIG. 2, *A.* Typical spherical oogonium with long, coiled, lateral stalk, androgynous antheridium, and mature oospores. *B, C, D, E.* Irregular, contorted oogonia with immature oospores. *F.* Terminal, spherical oogonium showing loose-coiling of hypha, mature oospores, and an undeveloped antheridium. *G.* Spherical oogonium with once-coiled, lateral stalk. *H.* Spherical oogonium with declinous antheridium and short-coiled stalk. *J.* Spherical oogonium with androgynous antheridium and short, bent, lateral stalk. *K.* Spherical oogonium showing tightly-coiled lateral stalk, papillations of oogonial wall, and both a declinous and an androgynous antheridium. *L.* Coiled, branched, lateral oogonial stalk with one spherical, one oval, and one constricted oogonium, all with immature oospores. All figures  $\times 840$ .

## STUDIES ON SOME UNUSUAL HETEROBASIDIOMYCETES FROM WASHINGTON STATE<sup>1</sup>

GEORGE NYLAND<sup>2</sup>

(WITH 6 FIGURES)

In a previous paper (6) the morphology and cytology of an undescribed Heterobasidiomycete was discussed. It was noted that, although the fungus had a spore stage indistinguishable from *Sporobolomyces*, it could not be placed in that genus because of the presence of mycelium with numerous clamp connections and with abundant, thick-walled, brown chlamydospores.

This paper describes in more detail the characteristics of the fungus and, to accommodate it, a new genus and species, *Sporidiobolus Johnsonii*, is proposed. A previously undescribed species of a closely related genus, *Itersonilia* Derx, is also described.

### *Sporidiobolus* gen. nov.

Ballistosporae in sterigmatibus formatae et per vim effusae. Sterigmata aetheria e mycelio aut statim e ballistosporis ascendunt. Ballistosporae ad propagationem multiplicatione sporarum aut ad gemmandum eodem modo fermenti aptae. Mycelium hyalinum septatum cum conjunctionibus. Chlamydosporae spisse circumdatae et fuscae, terminales aut intercalares.

Species typica: *Sporidiobolus Johnsonii*.

Ballistospores produced on tips of sterigmata of variable length and forcibly abjected by drop-excretion mechanism. Sterigmata arising as branches from mycelium or directly from ballistospores. Ballistospores capable of reproduction by repeating spores or by budding in yeast-like manner. Mycelium septate with clamp connections. Chlamydospores terminal or intercalary, brown, thick-walled, produced on mycelium.

<sup>1</sup> A condensed portion of a thesis presented to the Faculty, State College of Washington, May, 1948, in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Published as Scientific Paper No. 844, Agricultural Experiment Stations, Institute of Agricultural Sciences, State College of Washington, Pullman, Washington.

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**Sporidiobolus Johnsonii** spec. nov.<sup>3</sup>

Ballistospores  $6-13 \times 3.5-6.5 \mu$  (spores circa  $9 \times 5 \mu$  sunt), hyalinae, quae per saturam puniceae, leve flexae, incongruentes, reniformiatae-lunatae sunt, quae propagatione crescentiarum sporarum aut cellis quae eodem modo fermenti gemmant, quae aut in re gemmandis perseverare aut ballistosporas parere possunt, germinant. Ballistospores e mycelio parere etiam possunt. Mycelium linea media  $1.5-3 \mu$  septatum, copiosis cum conjunctionibus. Chlamydospores maturitate fulvae, linea media  $10-16 \mu$ , in brevibus hyphis formatae, terminales aut intercalares, cum conjunctione in caule in cuiusque spores radice.

Hab. In soro *Phragmidii rubi-idaei* (DC.) Karst. in foliis *Rubi idaei* L. Puyallup, Washington, U. S. A.

Ballistospores  $6-13 \times 3.5-6.5 \mu$  (ave.  $9 \times 5 \mu$ ), hyaline by transmitted light, salmon pink in mass, slightly curved, asymmetrical, reniform-lunate; germinating by forming sterigmata and repeating ballistospores, or by budding vegetative, yeast-like cells which in turn may continue to bud or may produce ballistospores. Ballistospores may also be produced from the mycelium on short sterigmata. Colony on malt agar appressed, hyphae  $1.5-3 \mu$  diameter, septate, with clamp connection at almost every septum. Chlamydospores hyaline when young, golden brown when mature,  $10-16 \mu$  diameter (ave.  $12 \mu$ ), wall  $1-1.5 \mu$  thick, contents oily, formed on hyphae in or on surface of matrix, usually on short lateral stalks, terminal or intercalary, with a clamp connection on each stalk at base of spore, often with a hyaline hyphal projection from distal end of chlamydospore.

Habitat: In pustule of *Phragmidium rubi-idaei* (DC.) Karst. on living leaf of *Rubus idaeus* L. vicinity of Puyallup, Washington, summer 1946.<sup>4</sup>

This species differs from species of *Sporobolomyces* only by its production of a well developed mycelium and chlamydospores. The budding, vegetative cells and the ballistospores are indistinguishable from those occurring in species of *Sporobolomyces*.

During the course of this work several other fungi resembling *Sporidiobolus* were isolated and one of these is described below as a new species in the genus *Itersonilia* Derx.

The genus *Itersonilia* was proposed by Derx (3) in May, 1948, to accommodate a fungus isolated by him for the first time in 1925. He obtained the fungus by attaching a leaf of *Althaea rosea* bearing

<sup>3</sup> Type specimen deposited in the Mycological Herbarium, State College of Washington, Pullman, Washington.

<sup>4</sup> Isolated by Dr. Folke Johnson and named in his honor.

numerous sori of *Puccinia malvacearum* Mont. to the lid of a petri dish. Of the many basidiospores of the rust that were projected downward onto the agar, he observed that the majority showed only the beginnings of a germination which ended with a sketchy secondary spore. But among the number some produced a true mycelium equipped with numerous clamp connections. From the mycelium there developed sparse aerial hyphae, and from these were produced long, tapering sterigmata on which were produced spores having the characteristic form of basidiospores. These were projected at maturity and continued the same cycle of development. The spores of this fungus were nearly the same size as those of *Puccinia malvacearum* so unless permitted to grow could not easily be distinguished from them. Derx (3) figures enlarged swollen cells with thin cell walls, each provided with a clamp at its base, on the mycelium of *Itersonilia*. He aptly calls his new species *I. perplexans*. Because his descriptions occur in a somewhat obscure journal they are repeated here for convenience (3).

*"Itersonilia Derx gen. nov.*

"Mycelium hyalinum, septatum, repens, fibuligerum ut typice in Basidiomycetibus; inflationibus terminalibus denique post excrescentionem terminalem saepe intercalaribus; sporophoris in aera ascendentibus, non-ramosis, apicem versus sensim attenuatis, in sterigma exeuntibus. Sporae solitariae, terminales, asymmetricae, uno latere plus minusve depressae, crassiusculae, non-falcatae, leves, hyalinae.

"Species typica: *Itersonilia perplexans* Derx spec. nov.

*"Itersonilia perplexans* Derx spec. nov.

"Mycelium 3-5  $\mu$  diam., in septis omnibus fibuligerum; inflationibus lato-ellipsoides vel obovoideis, 12-16  $\times$  9-10  $\mu$ , hyalinis. Sporae subreniformes vel ovoideae, leves, tenuiter tunicatae, 14-15  $\mu$   $\times$  8-10  $\mu$ —In foliis *Althaeae roseae* intra soros *Puccinia malvacearum*."

The term "ballistospore" has been used by Derx (3) at the suggestion of Dr. M. A. Donk to include those spores of the Basidiomycetes that are forcibly abjected at maturity by the drop-excretion mechanism studied by Buller (1). The general term seems appropriate, especially for the Sporobolomycetaceae and related forms, since it has not been established that the ballistospores in these fungi are actually basidiospores.

A species of *Itersonilia* was obtained by the writer, using essentially the same technique as Derx, from a dead leaf of *Acer macrophyllum* Pursh, in February, 1948. It is considered to dif-

fer sufficiently from *I. perplexans* to warrant the erection of a new species.

***Itersonilia pyriformis* spec. nov.<sup>5</sup>**

Ballistospores incongruentes, reniformatae-lunatae,  $11.7-19.5 \times 6.5-9.1 \mu$  (spores circa  $15.6 \times 7.3 \mu$  sunt) in sterigmatibus e mycelio aut multiplicatione formatae. Hyphae aetheriae, copiosae, candidae linea media  $2.4-2.6 \mu$ , hyphae hyalinae submergitae linea media  $1.2-1.5 \mu$  ambae septatae cum in prope quoque septo conjunctionibus. Chlamydospores in matrice hypharum, hyalinae, subtile circumdatae, aut pyriformatae aut globosae aut ovatae, spores circa  $16 \times 7.8 \mu$  sunt.

Hab. In foliis morto *Aceris macrophylli* Pursh.

Ballistospores asymmetrical, reniform-lunate,  $11.7-19.5 \times 6.5-9.1 \mu$  (average  $15.6 \times 7.3 \mu$ ), formed on sterigmata from the mycelium, or by repetition, but not budding in yeast-like manner. Mycelium on malt agar white, aerial, surface hyphae,  $2.4-2.6 \mu$  diameter, submerged hyphae hyaline,  $1.2-1.5 \mu$  diameter, septate, with clamp connections on almost every septum. Chlamydospores formed on hyphae in matrix, hyaline, thin-walled, pyriform to globose or oval, usually intercalary, average  $16 \times 7.8 \mu$ .

Habitat: Dead leaf of *Acer macrophyllum* Pursh, collected near Kent, Washington, U. S. A., February 26, 1948, by G. W. Fischer.

This species differs from *Itersonilia perplexans* in that the chlamydospores have no clamp connections associated with them and by the presence of abundant aerial mycelium on malt agar. Also the ballistospores of *I. pyriformis* are somewhat shorter than those of *I. perplexans*. The genus *Itersonilia* differs from *Sporidiobolus* in several ways. In *Sporidiobolus* the ballistospores may bud in a yeast-like manner but in *Itersonilia* they germinate directly to form a mycelium or occasionally form spores by repetition. The chlamydospores in *Sporidiobolus* are brown with thick walls whereas in *Itersonilia* they are hyaline with thin walls.

LIFE HISTORIES, PHYSIOLOGY, AND CYTOLOGY

I. SPORIDIOBOLUS JOHNSONII

*Life History.* The life history of *Sporidiobolus Johnsonii* has been described in a previous paper (6). A brief statement was

<sup>5</sup> Type specimen deposited in the Mycological herbarium, State College of Washington, Pullman, Washington.

made regarding germination of the chlamydospores after incubation at 35° C. for 6 days. Actually 12 to 14 days were required because the cultures were removed for 24 hours on alternate days. During the course of the sampling, numerous hyaline chlamydospores were observed to germinate directly by producing germ tubes that developed into a mycelium. These were judged to be young, hyaline chlamydospores and not rounded up ballistospores or vegetative budded cells because in most cases fragments of the mycelium could be observed attached to the spores.

When dilution transfers were made from old cultures, two types of colonies regularly resulted. The original mucous type formed

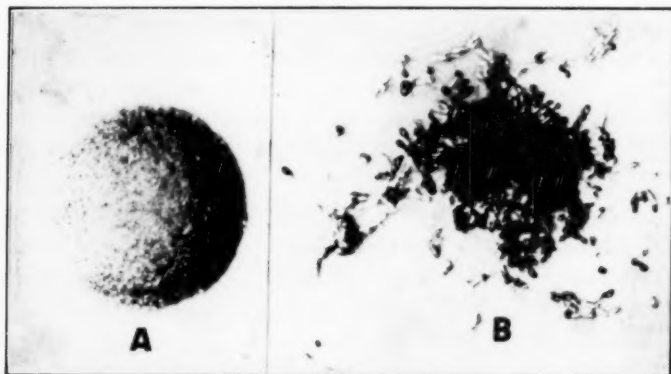


FIG. 1. *Sporidiobolus Johnsonii*. A, mucous and B, non-mucous type colonies. Note ballistospores on sterigmata in B. Approx.  $\times 200$ .

as a result of budding and a non-mucous type formed as the result of the production of long sterigmata and pseudomycelium consisting of elongated, vegetative, budded cells. Both types of colonies were formed from either vegetative, budded cells or from ballistospores. This phenomenon was also reported as occurring in *Sporobolomyces* by Derx (2). The appearance of the two types of colonies is shown (FIG. 1). The non-mucous type of colony was more abundant if transfers were made from the oldest portion of the culture.

Longevity of this species in culture exceeded 18 months after which sampling was discontinued. Viable ballistospores were pres-

ent as long as the cultures were not completely desiccated, after which time the new growth seemed to arise only from the mycelium. Both ballistospores and new mycelium were produced in every case.

*Temperature Requirements.* To determine cardinal temperatures, 250 cc. Erlenmeyer flasks containing 35 cc. of 2 per cent Difco potato dextrose agar were inoculated in quadruplicate with 6 mm. disks of agar inoculum containing mycelium and resting spores. Inoculum was prepared on potato dextrose agar in Petri dishes and after thirteen days disks were cut out from the margins

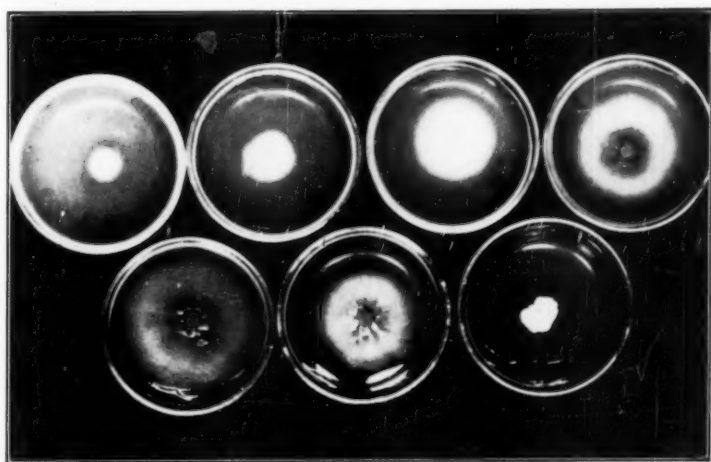


FIG. 2. *Sporidiobolus Johnsonii*. Final measurements after 18 days' growth at indicated temperatures.

of the colonies with a 6 mm. cork borer. Inoculum disks were transferred to the surface of the agar in the flasks with a flat-pointed needle. The flasks were placed in a constant temperature incubator at 26° C. for 17 hours prior to being incubated at the various temperatures, 5°, 10°, 15°, 20°, 25°, 30°, and 35° C. Measurements were made on the 5th, 9th, 13th and 18th days after incubation was begun. Cultures incubated at the optimum temperature (25° C.) completely covered the surface by the 18th day. The results are shown graphically (FIG. 2). Maximum growth of 80 mm. resulted at the optimum temperature of 25° C. Minimum

temperature for growth was approximately 5° C. and maximum temperature at which normal growth could take place was approximately 30° C. Some abnormal growth occurred at 35° C.

At 5° C. there was very little growth, the mycelium was profusely branched, very much appressed, and appeared somewhat mucose. Neither chlamydospores nor ballistospores were observed. At

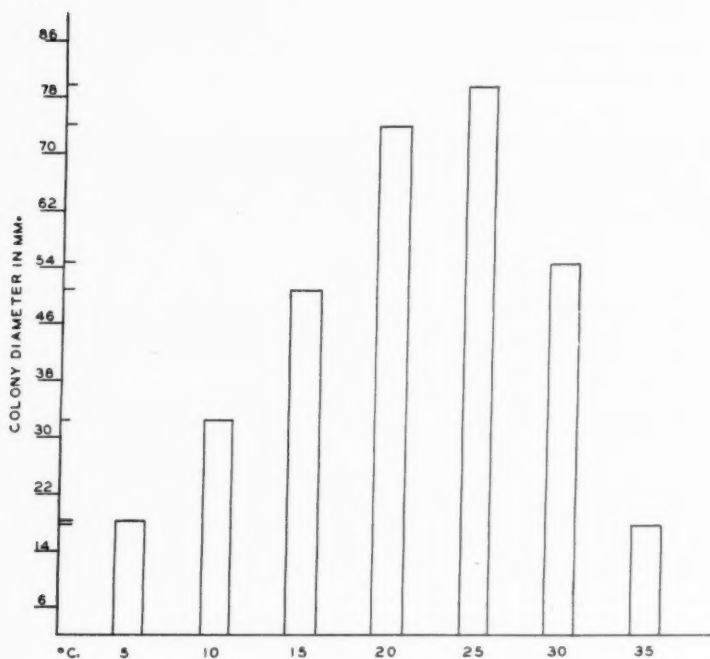


FIG. 3. *Sporidiobolus Johnsonii*. Reaction to various temperatures. Left to right, 5°, 10°, 15°, 20°, 25° (optimum), 30°, 35° C.

10° C. the colony appearance was much the same as at 5° C. but of somewhat greater diameter. Masses of chlamydospores were formed in the normal way but all were hyaline. At 15° C. there was a slight darkening or browning around the inoculum disk due to the brown walls of numerous chlamydospores. At 20° C. brown-walled chlamydospores were formed out from the center of the colony over about half the radius. A few ballistospores were



observed on sterigmata formed on the mycelium on the surface of the colony. At 25° C., the optimum temperature, chlamydospores were observed out to the very margin of the colony and even the margin had a brownish cast indicating rapid pigmentation of the spores after formation. Numerous ballistospores were observed. At 30° C. the margin of the brown, central area was irregular with dark streaks (chlamydospores) extending out almost to the margin of the colony. Some ballistospores were observed. At 35° C. the colony consisted entirely of ballistospores and budded vegetative cells formed in a pinkish, crusty mass. Examination under the microscope revealed that the ballistospores and vegetative cells were germinating to form secondary spores on long sterigmata in addition to budding. No true mycelium or chlamydospores were observed beyond the margin of the inoculum disk. These temperature reactions are illustrated graphically (Fig. 3).

*Nutrient Requirements.* The comparative rate and type of growth of *Sporidiobolus Johnsonii* was studied on eight agar media, as follows:

1. CD, Czapek's <sup>6</sup> with dextrose, 30 gms./liter
2. CS, Czapek's with sucrose, 30 gms./liter
3. CDP, Czapek's with dextrose plus peptone, 5 gms./liter
4. CSP, Czapek's with sucrose plus peptone, 5 gms./liter
5. C, Cornmeal agar (Difco)
6. P, Prune agar (Difco)
7. PD, Potato dextrose agar (Difco)
8. M, Malt agar (Difco)

Each agar medium was used in quadruplicate in 250 cc. Erlenmeyer flasks containing 25 cc. of medium. All were allowed to age two weeks before inoculation with 6 mm. agar blocks containing mycelium and chlamydospores. It was found that if the agar was allowed to age and dry out, somewhat more uniform mycelial growth resulted. Also aged agar inhibited the excessive formation of masses of vegetative budded cells and ballistospores. The 32 flasks were incubated at 25–26° C. for 15 days and colony measurements taken every other day. The results are presented graphically (Fig. 4). The organism grew most rapidly on malt agar

<sup>6</sup> Basic formula for Czapek's agar: MgSO<sub>4</sub> .5 gm., KH<sub>2</sub>PO<sub>4</sub> 1.0 gm., KCl .5 gm., FeSO<sub>4</sub> tr., NaNO<sub>3</sub> 2.0 gm., agar 25.0 gm., distilled H<sub>2</sub>O 1000 ml., and dextrose, sucrose, and peptone as indicated.

and most slowly on Czapek's with sucrose plus peptone. It apparently utilizes dextrose more efficiently than sucrose for mycelial growth as shown by the difference of 8 mm. in average diameter of the colonies. Dextrose seems to be responsible for the lavish production of budded cells and ballistospores which occurred on Czapek's with dextrose, since this does not occur on Czapek's with sucrose. Peptone also seems to stimulate vegetative budding

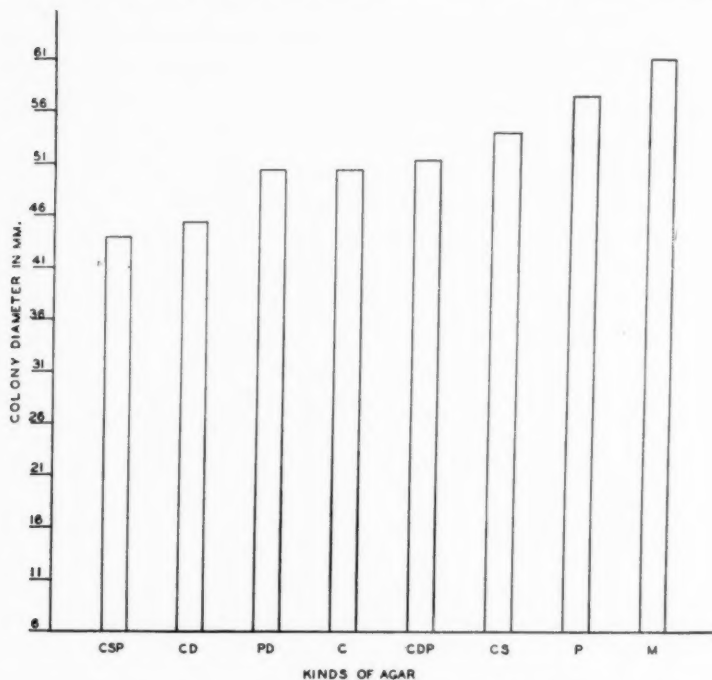


FIG. 4. *Sporidiobolus Johnsonii*. Colony diameter after 15 days' growth on 8 different media.

but to a lesser degree than dextrose. Czapek's with dextrose plus peptone resulted in larger colonies than Czapek's with dextrose alone. Czapek's with sucrose plus peptone, however, resulted in smaller colonies than Czapek's with sucrose alone. In Czapek's agar peptone, apparently, has a depressing effect on growth when associated with sucrose but a stimulatory effect when associated with dextrose, as contrasted to Czapek's with dextrose or sucrose

alone. Figure 5 shows the appearance of the colonies on the various media.

**CYTOLOGY.** It was shown that the ballistospores and the vegetative yeast-like cells of *Sporidiobolus Johnsonii* are uninucleate. Occasionally binucleate ballistospores were observed (6).

Because of the resemblance of this species to species of *Sporobolomyces*, it was considered advisable to examine as many species of *Sporobolomyces* as possible, cytologically and morphologically. The following available species<sup>7</sup> were studied:

*Sporobolomyces alborubescens* Derx, *S. gracilis* Derx, *S. odoratus* Derx, *S. pararoseus* Olsen and Hammar, *S. roseus* Kluver and van Niel, *S. pollaccii* Vernona and Ciferri, *S. rubicundulus* (Okunuki) Verona and Ciferri, *S. salmoneus* Derx, *S. salmonicolor* Kluver and van Niel, *S. salmonicolor* var. *polymyxa* Kluver and van Niel, *S. shibatanius* (Okunuki) Verona and Ciferri, *S. tenuis* Kluver and van Niel (species strain Lederer), *Bullera alba* (Hanna) Derx (= *Sporobolomyces albus* Hanna).

All of the above species were observed to have uninucleate vegetative cells and ballistospores, thus confirming the observations of Guilliermond (4) and Buller (1) who studied several of the species.

To obtain mycelium and chlamydospores of *Sporidiobolus Johnsonii* satisfactory for cytological study small blocks of agar were taken from the margins of actively growing colonies on malt agar and transferred to slides containing Mayer's adhesive. The slides were then placed in Petri plates on moist filter paper. Hyphae grew out from the blocks of agar onto the slides and formed resting spores there. After five to ten days the material was killed and fixed by exposing it to fumes of osmic acid in Fleming's weaker killing fluid. The preparations were then permitted to air-dry thoroughly. After drying, a sharp scalpel was used to sever the hyphae from the blocks of agar. When the slides were placed in the bleaching solution the agar blocks swelled and loosened, leaving only the radiating hyphal strands and chlamydospores on the slide, all in one plane. The standard iron-alum-haematoxylin method was used for staining the nuclei.

<sup>7</sup> Cultures of species of *Sporobolomyces* and *Bullera* were obtained from the Centraalbureau, Yeast Division, Delft, Holland.

It was found that mycelial cells were predominately binucleate, especially during earlier stages of growth. The chlamydospores at first are uninucleate but become binucleate upon formation of the clamp connection on the stalk at the base of the chlamydospore. The two nuclei fuse immediately and the spore assumes the characteristic golden-brown color. Attempts to stain the fusion nucleus in mature spores after complete pigmentation had occurred were not successful. Evidently, special treatment is required to remove

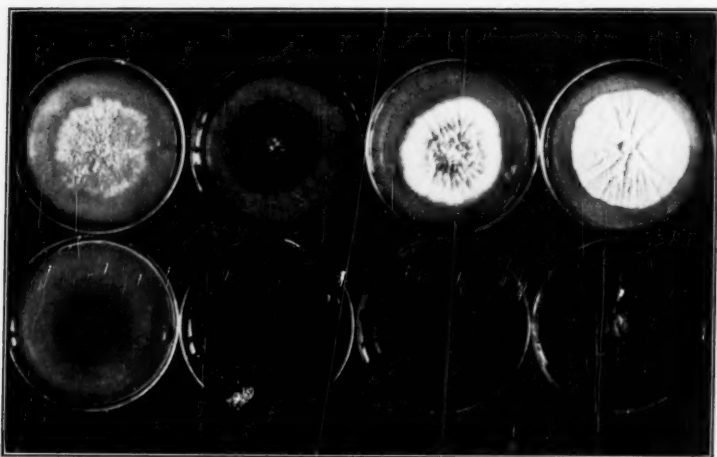


FIG. 5. *Sporidiobolus Johnsonii*. Reaction to various agar media. Upper left to right: Czapek's plus dextrose, Czapek's plus sucrose, Czapek's plus sucrose plus peptone, and Czapek's plus dextrose plus peptone. Lower left to right: Cornmeal, prune, potato dextrose, and malt agars.

oily materials within the spore before the nucleus can be stained in fully pigmented spores.

## II. *ITERSONILIA PYRIFORMIS*

*Life History.* On nutrient media the ballistospores of *Itersonilia pyriformis* germinate directly to form a mycelium provided with clamp connections at almost every septum (FIG. 6, B). Starting from a single ballistospore, visible colonies are formed within two days at room temperature. Within three or four days ballistospore production begins. The spores can easily be recognized

lying on the agar surrounding the margin of the advancing mycelium. By observing plate cultures under the microscope at low magnification they can also be observed attached to sterigmata which are produced as branches from the mycelium.

The young colonies are raised, rounded, and pure white due to the production of abundant, hyaline, aerial hyphae. As the colony becomes older, the lower surface becomes buff-colored to light tan on malt agar and surface growth becomes appressed.

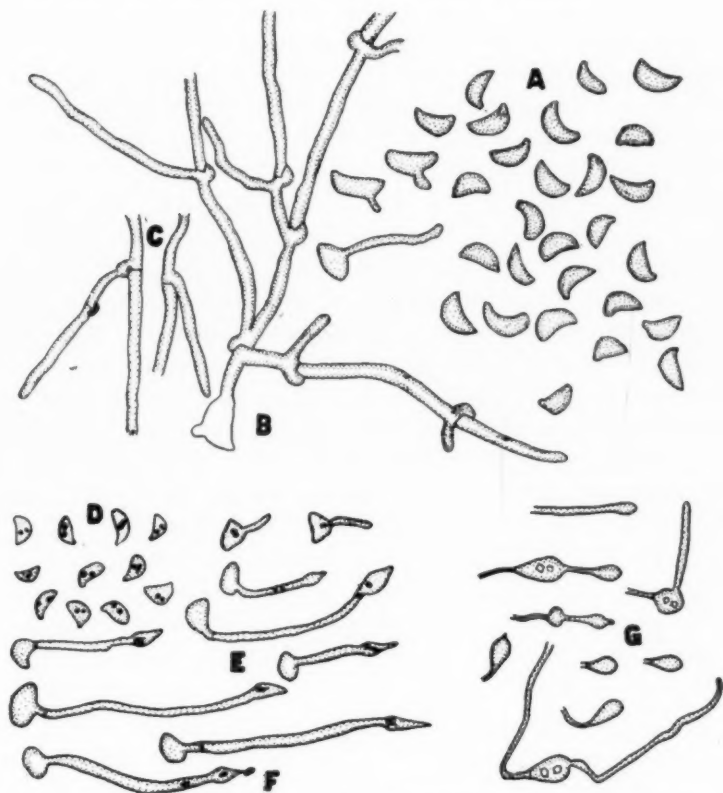


FIG. 6. *Itersonilia pyriformis*. A, Ballistospores; B, Germinating ballistospore showing mycelium and clamps; C, A typical branching arising from clamps; D, Binucleate ballistospores; E, Germinating ballistospores on slide coated with Mayer's adhesive; F, Formation of repeating spore; G, Chlamydospores. Drawn with the aid of a camera lucida. A, B, C, approx.  $\times 500$ . D, E, F, G, approx.  $\times 350$ .

When ballistospores germinate on slides that have been coated with Mayer's adhesive, they produce long germ tubes, usually unbranched, each with a swollen spear-point vesicle at the tip. The two nuclei in each ballistospore migrate through the germ tube into the vesicle (FIG. 6, E). Sometimes the germ tube continues vegetative growth but in other cases a secondary ballistospore is formed at the pointed tip of the vesicle (FIG. 6, F) and this spore receives the entire contents of the germ tube, including the two nuclei. Direct production of ballistospores is relatively uncommon on slides containing Mayer's adhesive.

When ballistospores germinate on water agar, either secondary ballistospores are formed directly from the primary ballistospores on short sterigmata, as in *Sporobolomyces* and *Sporidiobolus Johnsonii*, or germ tubes are produced that penetrate downward into the agar. The protoplasm of the germ tube migrates and remains at the growing tip, resulting in complete evacuation of the spore and most of the germ tube. Crosswalls are laid down immediately behind the migrating protoplasm. No clamp connections have been observed under these conditions. On nutrient agar there may be some protoplasmic migration in the germ tube but the tube soon branches and produces a normal mycelium with clamp connections. Germination of the chlamydospores of this species was not observed.

**CYTOLOGY.** The ballistospores of this species are binucleate in contrast to those of *Sporidiobolus Johnsonii* and those of species of *Sporobolomyces* (FIG. 6, D). Upon germination on nutrient agar they give rise to binucleate mycelia. The nuclei are usually closely associated in the mycelial cells. As far as could be determined the chlamydospores (FIG. 6, G) at maturity are uninucleate, probably containing a diploid fusion nucleus. Considerable difficulty was experienced in getting good preparations of stained chlamydospores.

#### DISCUSSION

When young cultures of *Sporidiobolus Johnsonii* are observed before mycelial production begins, they cannot be distinguished from some species of *Sporobolomyces*. The masses of ballistospores are pink in color; yeast-like cells are formed and bud exactly as they do in *Sporobolomyces*. Also, the production of bal-

listospores by repetition occurs in the same manner as in *Sporobolomyces*. Single spore cultures were used throughout so there is no question of culture purity.

The ballistospores of *Itersonilia pyriformis* do not exhibit the yeast-like budding nor do they have the pink color of those of *Sporidiobolus Johnsonii*. Also the ballistospores of *I. pyriformis* are larger than those of *S. Johnsonii*. There is considerable difference in the appearance of the colonies of these two fungi when grown on the same medium. *S. Johnsonii* produces an appressed growth with very few aerial hyphae. Also, the colony has a brownish cast due to the masses of brown-walled chlamydospores formed. *Itersonilia pyriformis*, in contrast, produces a luxuriant aerial growth, very white and cottony, at least in young cultures. The chlamydospores formed are thin-walled and hyaline. No clamp connections have been observed in association with the chlamydospores in this species.

*Itersonilia perplexans* Derx is reported (3) to produce "inflated bodies" having clamp connections associated with them. No doubt these inflated bodies, which may be terminal or intercalary, are comparable to the chlamydospores of *Sporidiobolus Johnsonii* and *I. pyriformis*. In *S. Johnsonii* the chlamydospores are thick-walled and brown, being definitely resting spores, whereas, in *I. pyriformis* and *I. perplexans* Derx, they are thin-walled and hyaline. According to Derx (3), there is always a clamp connection associated with the chlamydospore of *I. perplexans*. This is also true of *S. Johnsonii* but not of *I. pyriformis*.

The writer is in agreement with Derx (3) that Stempel (7) probably had a species of *Itersonilia* in culture rather than *Entyloma calendulae* when he described his "Mycel II" and "Halbmundkonidien."

Derx (3) has amended the description of the family Sporobolomycetaceae to include the genera *Tilletiopsis* and *Itersonilia*. The genus *Sporidiobolus*, however, has characters that exclude it from the Sporobolomycetaceae. The presence of chlamydospores in which two nuclei fuse would appear to constitute a sexual phase on the order of that occurring in the smuts. Martin (5) considers the family Sporobolomycetaceae as being composed of imperfect

fungi and consequently classifies it among the Fungi Imperfecti. *Sporidiobolus* with its apparent sexual stage could not, therefore, be placed in this family.

In the genus description of *Tilletiopsis*, provisionally proposed by Derx (2) in 1930 and accepted by him in 1948 (3), no mention is made of chlamydospores or of a sexual stage. However, the writer has isolated two species of *Tilletiopsis*<sup>\*</sup> which produce chlamydospores that are strikingly similar to those found in the genus *Entyloma*. There is a good possibility that, when the chlamydospores of these two species are studied cytologically, a sexual phase similar to that in *Sporidiobolus* will be revealed. Preliminary work to date has suggested that such will be the case. If so, *Tilletiopsis* could not logically be included in the Sporobolomycetaceae.

As indicated above, the chlamydospores of *Itersonilia pyriformis* contain a single nucleus. The hyphal cells of this fungus are typically binucleate. If further cytological study reveals that the young chlamydospores are binucleate, a sexual stage such as occurs in *Sporidiobolus* would be demonstrated. In that case, neither *Tilletiopsis* nor *Itersonilia* could be included in the family Sporobolomycetaceae as it now stands.

For these reasons, it is considered premature to include the genera *Tilletiopsis* and *Itersonilia* in the family Sporobolomycetaceae of the Fungi Imperfecti as Derx (3) has proposed.

#### SUMMARY

1. *Sporidiobolus Johnsonii*, a new genus and species, is described to accommodate an heterobasidiomycetous fungus isolated from a pustule of *Phragmidium rubi-idaei* (DC.) Karst, in a leaf of *Rubus idaeus* L.

2. A name for a previously undescribed species of *Itersonilia* Derx is proposed for a fungus isolated from a dead leaf of *Acer macrophyllum* Pursh.

3. The life histories, physiology, and nuclear conditions of the above fungi are discussed.

<sup>\*</sup> The results of this study will be published in a subsequent paper.



4. The validity of the inclusion of the genera *Tilletiopsis* and *Itersonilia* by Derx in the family Sporobolomycetaceae is questioned.

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## NOTES AND BRIEF ARTICLES

### TAPHRINA LATA Palm

In the writer's recent monograph (Univ. Kansas Sci. Bull. **33**: 3-167, 1949) it is stated regarding certain specimens (in the Stockholm Museum) collected by Palm at Tungelsta, Sweden: "It seems highly probable that this is the material Palm used in describing *Taphrina lata*." This fungus is then reduced to synonymy as *Taphrina carnea* Johanson.

Dr. J. A. Nannfeldt has kindly pointed out the probability of error in this treatment of *T. lata*. A reexamination of the material and of the writer's notes makes it clear that the specimens in question must have been those collected by Palm at Tungelsta and called by him (Arkiv. f. Bot. **15** (4): 1-4, 1917) *Taphrina janus*. (*T. janus* is, by the writer's treatment, synonymous with *T. carnea*.) It could not by any possibility be the type material of *T. lata*.

A further error is the writer's report (l.c.) that Palm described *T. lata* as "... affecting only young seedlings a foot or less tall." No such statement occurs in Palm's paper (l.c.). Palm described *Taphrina lata* as affecting individual shoots of *Betula pubescens* Ehrh., causing lateral enlargement and slight thickening of leaves, and enlargement of twigs. He distinguished it further by its broad asci: *asci*  $40-45\ \mu \times 18-22\ \mu$ ; *stalk cells*  $16-20\ \mu \times 25-33\ \mu$ .

*Taphrina lata* Palm must be reconstituted as a valid species. Any doubts about it can only be resolved by finding the type material or by collection of material from the type locality.—A. J. MIX, Dept. of Botany, Univ. of Kansas, Lawrence, Kansas.

### A NOTE ON INONOTUS AMPECTENS MURRILL

This very interesting fungus was found and described by William A. Murrill growing on living twigs of *Asimina* in Georgia. On July 28, 1949, Mr. Thomas J. Wesson, Jr., on a field trip found this form growing on the twigs of *Asimina parviflora* (Michx.) Dunal and brought it to the writer who sent it to Dr. J. N. Couch for identification.

On checking the location, this author found this fungus growing on the small papaw along the banks of the Ochlockonee River in Leon county, Florida. The papaws were scattered for 350 feet along the sides of a trail through the dense woods. The fungus occurred on approximately two-thirds of the scattered plants noted. There were 1-4 fruiting bodies per plant.

In a measured space, 15 by 24 feet, 25 knee-high shrubs were counted with an average of 2 thalli per plant. In a second measured area, 15 by 15 feet, 12 waist high papaws were counted with 2-3 fungi per plant.

*Inonotus amplexans* Murrill usually occurs in the fork of two branches and is attached to both adjacent branches, or to a branch and a leaf petiole. Only occasionally have we found it attached directly to the main stem. Pore surfaces are always oriented so that they project towards the ground. The area of the stem directly under the points of attachment is usually darkened considerably.

It seems to be quite unusual for this fungus to occur in such large quantities. Dr. Herman Kurz who has been collecting in this area for 20 years reports that he has never observed this fungus before this year.—A. W. ZIEGLER, Dept. of Botany, Florida State University.

# MYCOLOGIA

## FINANCIAL STATEMENT

(July 1, 1948-June 30, 1949)

Unexpended reserve, July 1, 1948 .....	\$ 4,680.69
<i>Current receipts (joint funds):</i>	
Mycological Society (members' subscriptions) ...	\$2,006.00
Subscriptions .....	3,544.75
Sale of back sets (vol. 25 and later) .....	538.00
Payment for excess pages .....	61.00
	<hr/>
	\$6,149.75
<i>Special funds:</i>	
Sale of back sets (vol. 1-24) and index .....	\$ 185.24
Interest on endowment .....	572.00
	<hr/>
	\$ 757.24
Total receipts .....	<hr/>
	\$ 6,906.99
Total on hand .....	<hr/>
	\$11,587.68
<i>Cost of printing and distribution:</i>	
Printing, binding, mailing 6 issues .....	\$5,206.37
Engraving .....	638.15
	<hr/>
	\$5,844.52
Replacing exhausted issues .....	554.86
Miscellaneous office expenses .....	472.07
	<hr/>
Total cost .....	\$ 6,871.45
Balance .....	<hr/>
	\$ 4,716.23
Unexpended reserve, June 30, 1949 .....	4,716.23
Endowment fund .....	14,000.00
	<hr/>
Total on hand .....	\$18,716.23

The above MYCOLOGIA funds are administered by the New York Botanical Garden, and the balances at June 30, 1949, are in agreement with the amounts shown in the financial statements of that organization which have been examined by Price, Waterhouse & Co.

## INDEX TO VOLUME XLI \*

### INDEX TO AUTHORS AND TITLES

- Alexopoulos, Const. J. and Butler, Edward E.** Conidia-like structures in *Plectania coccinea* 180-182, 1 figure.
- Ames, Lawrence M.** New cellulose destroying fungi isolated from military material and equipment 637-648, 42 figures
- Arnaud, G. and Bitancourt, Agesilau A.** The perfect stage of the fungus causing spot anthracnose of *Arbutus Unedo* L. 320-322, 1 figure
- Barnett, Horace L. (with Lilly, Virgil Greene).** The influence of concentrations of nutrients, thiamin, and biotin upon growth, and formation of perithecia and ascospores by *Chaetomium convolutum* 186-196, 4 figures
- Benham, Rhoda Williams (with Bocobo, Florante C.).** Pigment production in the differentiation of *Trichophyton mentagrophytes* and *Trichophyton rubrum* 291-302
- Benjamin, Richard K.** Two species representing a new genus of the Chaetomiaceae 346-354, 33 figures
- Bitancourt, Agesilau A. (with Arnaud, G.).** The perfect stage of the fungus causing spot anthracnose of *Arbutus Unedo* L. 320-322, 1 figure
- Bocobo, Florante, C. and Benham, Rhoda Williams.** Pigment production in the differentiation of *Trichophyton mentagrophytes* and *Trichophyton rubrum* 291-302
- Bodman, Sister Mary Cecilia.** The genus *Heterochaete* in the United States 527-536, 4 figures
- Brodie, Harold J.** *Cyathus vernicosus*, another tetrapolar bird's nest fungus 652-659, 2 figures
- Butler, Edward E. (with Alexopoulos, Const. J.).** Conidia-like structures in *Plectania coccinea* 180-182, 1 figure
- Coker, W. C. and Rebell, G. C.** *Colus Schellenbergiae* again 280-282, 1 figure
- Cook, Melville T.** Species of *Synchytrium* in Louisiana. V. A new species on *Sambucus canadensis* 24-27, 9 figures
- Cooke, William Bridge.** *Oxyporus nobilissimus* and the genus *Oxyporus* in North America 442-455, 10 figures; Western fungi—I 601-622, 22 figures
- Couch, John N.** The taxonomy of *Septobasidium polypodii* and *S. album* 427-441, 25 figures
- Cummins, George Baker (with Thirumalachar, Mandayam Jeersannidhi).** The taxonomic significance of sporogenous basal cells in the Uredinales 523-526
- Diehl, William W.** Article 64 and the nomenclature of lichens 89-91; Concerning the identity of Iterson's cellulytic *Mycogone* 277-279

\* This index prepared by Henry A. Imshaug.

- Drechsler, Charles.** An *Endocochlus* having binary helicoid thalli of left-handed rotation 229-251, 6 figures; A nematode-capturing fungus with anastomosing clamp-bearing hyphae 369-387, 4 figures
- Dulaney, Eugene L.** Observations on *Streptomyces griseus*. III. Carbon sources for growth and streptomycin production 1-10
- , **Ruger, Myrle and Hlavac, Charles.** Observations on *Streptomyces griseus*. IV. Induced mutation and strain selection 388-397, 2 figures
- Elliott, Eugene W.** The swarm-cells of Myxomycetes 141-170, 25 figures
- Ellison, Bernard (with Sparrow, Frederick Kroeber).** *Olpidiopsis Schenkiana* and its hyperparasite *Ectrogella Besseyi* n. sp. 28-35, 1 figure
- Gilkey, Helen M.** Sanford Myron Zeller October 19, 1884-November 4, 1948 357-368
- Groves, J. Walton and Leach, A. Mavis.** The species of *Tympanis* occurring on *Pinus* 59-76, 7 figures
- Hansen, H. N. (with Hirsch, Hilde E. and Snyder, William C.).** Chromosome numbers in the Hypocreaceae 411-415, 2 figures
- Hirsch, Hilde E., Snyder, William C. and Hansen, H. N.** Chromosome numbers in the Hypocreaceae 411-415, 2 figures
- Hlavac, Charles (with Dulaney, Eugene L. and Ruger, Myrle).** Observations on *Streptomyces griseus*. IV. Induced mutation and strain selection 388-397, 2 figures
- Jenkins, Anna Eliza (with Limber, Donald P.).** *Catacauma sabal* Chardon identified in the United States and Mexico 537-544, 2 figures; Weedon's *Myriangium* on *Sabal* 545-552, 2 figures
- Johnson, Aaron G. (with Lefebvre, Camille Leon).** The *Helminthosporium* on *Buchloe dactyloides* 202-206, 3 figures
- (with Lefebvre, Camille Leon and Sherwin, Helen S.). An undescribed species of *Periconia* 416-419, 1 figure
- Johnson, T. W., Jr.** A new species of *Achlya* with coiled oogonial stalks 678-685, 2 figures
- Kanouse, Bessie Bernice.** Studies in the genus *Otidea* 660-677, 21 figures
- Karling, John Sidney.** A new *Olpidiopsis* parasite of *Karlingia rosea* from Maryland 270-276, 17 figures; New monocentric eucarpic chytrids from Maryland 505-522, 78 figures
- Kern, Frank Dunn (with Thirumalachar, Mandayam Jeersannidhi).** Notes on some species of *Phakopsora* and *Angiopsora* 283-290, 3 figures
- Korf, Richard P.** *Wynnea americana* 649-651, 1 figure
- Leach, A. Mavis (with Groves, J. Walton).** The species of *Tampanis* occurring on *Pinus* 59-76, 7 figures
- Lefebvre, Camille Leon and Johnson, Aaron G.** The *Helminthosporium* on *Buchloe dactyloides* 202-206, 3 figures
- , —, and Sherwin, Helen S. An undescribed species of *Periconia* 416-419, 1 figure
- Lilly, Virgil Greene and Barnett, Horace L.** The influence of concentrations of nutrients, thiamin, and biotin upon growth, and formation of perithecia and ascospores by *Chaetomium convolutum* 186-196, 4 figures
- Limber, Donald P. and Jenkins, Anna Eliza.** *Catacauma sabal* Chardon identified in the United States and Mexico 537-544, 2 figures; Weedon's *Myriangium* on *Sabal* 545-552, 2 figures

- Ling, Lee.** A second contribution to the knowledge of the Ustilaginales of China 252-269, 2 figures
- and **Stevenson, John Albert.** A note on the genus *Kuntzeomyces* 87-89, 1 figure
- Lucas, George Blanchard.** Studies on the morphology and cytology of *Thielavia basicola* Zopf 553-560, 1 figure
- McVeigh, Ilda (with Robbins, William J.).** The "dual phenomenon" and *Trichophyton mentagrophytes* 128-140, 1 figure
- Mains, Edwin B.** (Book Review) International Rules of Botanical Nomenclature, compiled from various sources by W. H. Camp, H. W. Rickett, and C. A. Weatherby 95; New species of *Torrubiella*, *Hirsutella* and *Gibellula* 303-310, 2 figures
- Martin, George Willard.** The genus *Ceracea* Cragin 77-86, 13 figures
- Meyer, Samuel L.** Some Xylarias from Panama 91-92
- and **Meyer, Vesta Green.** Some coprophilous ascomycetes from Panama 594-600
- Meyer, Vesta Green (with Meyer, Samuel L.).** Some coprophilous ascomycetes from Panama 594-600
- Miller, Julian H.** A revision of the classification of the ascomycetes with special emphasis on the pyrenomycetes 99-127, 37 figures
- Mix, A. J.** *Taphrina lata* Palm 702
- Murrill, William Alphonso.** Three new fleshy fungi 490-491
- Nyland, George.** Studies on some unusual Heterobasidiomycetes from Washington State 686-701, 6 figures
- Olive, Lindsay Shepherd.** Target spot of Cowpea and Soybean 355; A cytological study of typical and atypical basidial development in *Gymnosporangium clavipes* 420-426, 14 figures
- Poitras, Adrian W.** A new aquatic species of *Pythium* 171-176, 17 figures
- Rebell, G. C. (with Coker, W. C.).** *Colus Schellenbergiae* again 280-282, 1 figure
- Reischer, Helen Simpson.** Preservation of Saprolegniaceae by the mineral oil method 177-179; A new species of *Achlya* 339-345, 5 figures; The effect of temperature on the papillation of oogonia of *Achlya colorata* 398-402, 6 figures
- Robbins, William J. and McVeigh, Ilda.** The "dual phenomenon" and *Trichophyton mentagrophytes* 128-140, 1 figure
- (with **Stebbins, Mary E.**). Mineral oil and preservation of fungous cultures 632-636
- Rogers, Donald Philip.** Proposals for amendment of the International Rules 215-221; Proposed facsimile reprints of mycological classics 355-356
- Routien, John B.** *Crebrothecium Ashbyi* 183-185
- Ruger, Myrle (with Dulaney, Eugene L. and Hlavac, Charles).** Observations on *Streptomyces griseus*. IV. Induced mutation and strain selection 388-397, 2 figures
- Salvin, Samuel B.** Phase-determining factors in *Blastomyces dermatitidis* 311-319, 2 figures
- Shaw, Charles Gardner.** Downy mildew of *Urtica* in the United States 197-201, 1 figure; Nomenclatorial problems in the Peronosporaceae 323-338, 2 figures.

- Shear, Cornelia Lott.** Special committee on fungi for the International Botanical Congress at Stockholm 221-222; Schweinitz-Fries letters 456-461, 2 figures
- Sherwin, Helen S. (with Lefebvre, Camille Leon and Johnson, Aaron G.).** An undescribed species of *Periconia* 416-419, 1 figure
- Singer, Rolf.** The genus *Gomphidius* Fries in North America 462-489, 3 figures
- Snyder, William C. (with Hirsch, Hilde E. and Hansen, H. N.).** Chromosome numbers in the Hypocreaceae 411-415, 2 figures
- Solheim, W. G.** Studies on Rocky Mountain fungi—I 623-631
- Sparrow, Frederick Kroeber and Ellison, Bernard.** *Olpidiopsis Schenki-ana* and its hyperparasite *Ectrogella Besseyi* n. sp. 28-35, 1 figure
- Sprague, Roderick.** Some leafspot fungi on western Gramineae—IV 493-504, 1 figure
- Stebbins, Mary E. and Robbins, William J.** Mineral oil and preservation of fungous cultures 632-636
- Stevenson, John Albert.** Mycological Society of America. Report of the 1947 foray 207-215; William Henry Long, 1867-1947 223-228
- (with **Ling, Lee**). A note on the genus *Kuntzeomyces* 87-89, 1 figure
- Sumstine, David R.** The Albert Commons Collection of fungi in the herbarium of the Academy of Natural Sciences in Philadelphia 11-23
- Thirumalachar, Mandayam Jeersannidhi and Cummins, George Baker.** The taxonomic significance of sporogenous basal cells in the Uredinales 523-526
- and **Kern, Frank Dunn.** Notes on some species of *Phakopsora* and *Angiopsora* 283-290, 3 figures
- Wehmeyer, Lewis Edgar.** (Book Review) Biology of pathogenic fungi, with foreword by J. G. Hopkins, M.D. Edited by Walter J. Nickerson 95-96; Studies in the genus *Pleospora*—I 565-593, 17 figures
- Wolf, Frederick A.** Two unusual conidial fungi 561-564, 5 figures
- Wolf, Frederick T.** Amino acids in the biosynthesis of penicillin 403-410
- Zeller, Sanford Myron.** Keys to the orders, families, and genera of the Gasteromycetes 36-58
- Ziegler, Arthur William.** A note on *Inonotus amplexans* Murrill 702-703

## INDEX TO GENERA AND SPECIES

New names, the final members of new combinations, and the page where they appear, are in **bold face type**. Mistakes in the spelling of scientific names encountered in the text are corrected in the index.

- Absidia* 633  
*Abstoma* 50  
*Acanthocystis* 636  
*Acanthothecium* 563  
*Achlya* 31, 32, 35, 177-179, 339, 345, 402, 678, 681-682, 684-685; colorata 398-402; contorta 681; flagellata 275; glomerata 685; Orion 681; papillosa 681; polyandra 340-342, 345; proliferoides 681; racemosa 340-342, 344-345, 398; racemosa f. *Pringsheimii* 398; racemosa var. *spinosa* 398; racemosa var. *stelligera* 398; recurva 681, 685; **Sparrowii** 339-345; **spiracaulis** 678, 680-685  
*Achorion* 634  
*Achrotelium ichnocarpi* 524; lucumae 524  
*Acladium* 634



- Acremoniella* 277  
*Acremonium* 277, 634  
*Acrotheca* 96  
*Actinomyces* 235, 247, 397, 633;  
     *griseus* 397  
*Accidium* *Urticae* 199  
*Aegerita candida* 22; *epixylon* 214  
*Aethalium septicum* 164  
*Agaricus* 18, 217, 633; *glutinosus*  
     484; *maculatus* 475; *rutilus* 473  
*Agrocybe* 633  
*Aleuria* 675; *rhenana* 210  
*Aleurina atrovinosa* 210  
*Aleurodiscus* 633; *candidus* 212  
*Alnicola* 633  
*Alpova* 39  
*Alternaria* 634; *brassicae* 14  
*Amanita* 636; *caesarea* 212, 490;  
     *calyptrata* 364; *calyptroderma* 364;  
     *muscaria* 212; *porphyria* 490; *ru-*  
     *bescens* 212; *solitaria* 212  
*Amanitopsis floridana* 490; *strangu-*  
     *lata* 490; *vaginata* 490; *volvata* 490  
*Amaurochaete atra* 161; *fuliginosa*  
     161  
*Angiopsora* 284-289; ***Ampelopsisid***  
     **288-289**; *compressa* 289; *divina*  
     288; ***Hansfordii* 286**, 289; *len-*  
     *ticularis* 286, 289; ***melaena* 285-**  
     **286**, 289; *Meliosmae* 288-289;  
     *pallescens* 289; *phakopsoroides*  
     289; ***venezuelana* 287**, 289; *zeae*  
     286, 289  
*Anthostoma* 111-112  
*Anthostomella* 111, 208; ***ratibidae***  
     **623**  
*Aphanomyces* 245; *laevis* 275  
*Aphanomycopsis* 33  
*Apioportha* 633  
*Apiosporina Collinsii* 126  
*Aplanes* 678  
*Aporophallus* 45  
*Arachnion* 48  
*Arachniopsis* 49  
*Araneosa* 48  
*Arcangiella* 41  
*Arcyria anomala* 162; *cinerea* 145,  
     161, 170; *denudata* 145, 159, 161;  
     *digitata* 161; *ferruginea* 161; *in-*  
     *carinata* 145, 161; *nutans* 161;  
     *Oerstedtii* 161; *pomiformis* 161;  
     *punicea* 161; *stipata* 164  
*Argomycetella* 525  
*Armillaria* 633; *aurantia* 212; *mella*  
     226, 362-363  
*Armillariella* 636  
*Arrhytidia* 77-80, 82-83, 85-86; *enata*  
     85; *flava* 80-81, 85-86; *involuta*  
     81-82, 85-86; *pustulata* 85  
*Arthrinium bicornae* 602-603  
*Arthuria* 284, 288-289  
*Ascobolus immersus* 595  
*Ascochyta utahensis* 500  
*Ascodesmis microscopica* 595; *por-*  
     *cina* 595  
*Ascophanus argenteus* 596; *carneus*  
     596; *granulatus* 597  
*Ascopolyporus* 109  
*Ascotricha* 353, 646-647  
*Aseroë* 46  
*Ashbya* 183, 633, 635; *gossypii* 636  
*Aspergillus* 634, 636  
*Asterophlyctis* 510, 521; *sarcoptoides*  
     270  
*Astraeus* 53  
*Auerswaldia examinans* 119, 127;  
     *puccinioides* 118, 121, 127  
*Auricularia* 435, 633  
  
*Badhamia* 141; *affinis* 143, 161; *cap-*  
     *sulifera* 161; *Curtisii* 161; *gracilis*  
     146; *hyalina* 161; *lilacina* 161;  
     *macrocarpa* 161; *magna* 162; *or-*  
     *biculata* 157; *ovispora* 161; *pani-*  
     *cea* 146, 161; *rubiginosa* 161;  
     *utricularis* 162  
*Baeodromus* 284, 288-289; ***domini-***  
     ***cana* 284**  
*Baeostrateporus* 444  
*Balansia* 109; *hypoxylon* 208  
*Basidiophora Kellermanii* 325  
*Battarraea* 38, 51, 53; *laciniata* 57,  
     228  
*Belonium carnosulum* 210  
*Biatorella* 59  
*Bitzea* 525; *ingae* 524  
*Blastomyces brasiliensis* 317, 318;  
     *dermatitidis* 311, 313-319  
*Blastotrichum puccinioides* 277  
*Blumenavia* 46  
*Boletellus betula* 214  
*Boletinus* 480; *pictus* 214; *porosus* 23  
*Boletus bicolor* 214; *edulis* 214; *fer-*  
     *rugineus* 214; ***focculosipes* 491**;  
     *fumosipes* 214; *griseus* 214; *illu-*  
     *dens* 214; *miniato-olivaceus* 214;  
     *modestus* 214; *nobilis* 214; *peckii*  
     214; *populinus* 452; *separans* 214;  
     *vermiculosus* 214  
*Bombardia arachnoidea* 598; *fascicu-*  
     *lata* 208  
*Botryodiplodia* 634  
*Botryosphaeria Ribis* 121, 127, 208  
*Botryotinia* 633  
*Botrytis* 634; *cinerea* 363; *destructor*  
     331; *effusa* 329; *farinosa* 329;  
     *fulva* 12; *ganglioniformis* 329;  
     *geniculata* 12; *grisea* 330; *infes-*  
     *tans* 197; *nivea* 334; *parasitica*  
     330; *pygmaea* 334; *streptothrix*  
     12-13; *Urticae* 197, 331; *viticola*  
     336; *vulgaris* 13

- Bovista 49  
 Bovistella 48  
 Bovistina 50, 57, 227  
 Bovistoides 49  
 Brachysporium 614, 618-619, 634;  
   pedunculatum 614, 617; puccinio-  
   ides 614, 617; sphaerocolum 615  
 Bremia 326; **ganglioniformis** 326;  
   Lactucae 326  
 Brevilegnia 178-179  
 Broomcia 49  
 Bubakia 289  
 Bulgaria 649; inquinans 182  
 Bullera 695; alba 695  
 Bulliardella 123  
 Burrillia ajrekari 256  
  
 Cadophora 634  
 Calbovista 49  
 Calciopsis pinea 209  
 Calocera 633; cornea 212  
 Caloderma 52  
 Calodon 633; geogenium 212; scro-  
   biculatum 212; velutinum 212; zo-  
   natum 212  
 Calonectria 411-412, 414-415; rigi-  
   diuscula 411, 415  
 Calostoma 54; cinnabarina 214  
 Calvarula 43  
 Calvatia 49, 52, 633  
 Candida albicans 299, 317  
 Cantharellus floccosus 212  
 Castoreum 50  
 Catacauma 538, 541, 543, 547; sabal  
   537, 539-542, 544-545, 551-552  
 Cenangella pithya 61, 68  
 Cenangium Pinastri 60; pithyum 61-  
   62  
 Cephalophora 561-563; irregularis  
   561; tropica 561-563  
 Cephalosporium 634  
 Cephalothecium 634  
 Ceracea 77, 79-80, 82-83, 86, 633;  
   aureo-fulva 85-86; aureofulva 81;  
   canadensis 85; corticioides 81;  
   crustulina 77, 84-86; elongata 85;  
   Lagerheimii 81, 85-86; vernicosa  
   77-78, 86  
 Ceratiomyxa 144, 156, 168-169; fruti-  
   culosa 145, 162, 170, 208  
 Ceratium 162  
 Ceratosphaeria 209  
 Ceratostomella 353, 633; fimbriata  
   186, 194, 196  
 Cercospora 18, 355, 495; aclyphae 14;  
   acidiae 14; ageratoides 14; althae-  
   ina 14; ampelopsidis 14; asclepia-  
   dis 14-15; atra 15; avicularis 15;  
   boehmeriae 15; brachiata 15; bri-  
   areus 15; callae 15; cana 15;  
   cephalanthi 15; chenopodii 15;  
   circumscissa 15; clavata 15; Com-  
   monsii 18; condensata 15; cruci-  
   ferarum 15; daturae 15; demetri-  
   ana 16; desmodii 16; deutziae 16;  
   diantherae 16; diodiae 16; diosco-  
   reae 16, 214; echinocystis 16; ef-  
   fusa 16; elephantopidis 16; ferru-  
   ginea 16; flagellaris 16; galii 15;  
   gentianicola 16; gnaphaliaceae 16;  
   granuliformis 16; heucherae 16;  
   houstoniae 16; hydrocotylis 16;  
   hydropiperis 17; infuscans 16-17;  
   leptosperma 17; lini 17; liquidam-  
   baris 17; monoica 17; nesaeae 17;  
   nymphaceae 17; oculata 17; om-  
   phacodes 214; osmorrhizae 17;  
   pachyspora 17; polygonacea 17;  
   polygonacea var. avicularis 17;  
   polygonorum 17; racemosa 17;  
   rhuina 17; rubi 214; sabbatae 17-  
   18; sagittariae 18; sanguinariae  
   18; senecionis 18; serpentaria 18;  
   simulata 18; smilacina 18, 214;  
   smilacis 18, 214; squalidula 18;  
   Stylosanthes 18; symplocarpi 18;  
   thaspii 18; tuberosa 18; venturio-  
   ides 14, 214; verbasicola 18;  
   vexans 214; vignicola 355; violae  
   18  
 Cercosporiella 495; cana 15  
 Cercosporidium 634  
**Cerinomyces** 79, 82-83, 86; **cana-**  
**densis** 85-86; **crustulinus** 85-86;  
**pallidus** 83-86; Zelleri 361  
 Cerotelium 284, 287-289; desmium  
   287  
 Chaconia 523-525  
 Chaetomella 634  
 Chaetomidium 353, 647  
 Chaetomium 346, 353-354, 633, 638-  
   639, 642-647; **atrobrunneum** 641,  
   648; bostrychodes 595, 599; can-  
   croideum 646; **causiaeformis** 644,  
   648; convolutum 186-187, 192, 194-  
   195; **cristatum** 639, 648; **cupreum**  
   642, 648; dolichotrichum 646;  
   elatum 646; erectum 646; **gangli-**  
   **gerum** 640, 647-648; globosum  
   646; indicum 646; microcephalum  
   646; murorum 646; ochraceum  
   646; pachypodioides 646; reflexum  
   646; **seminudum** 642, 647-648;  
   spirochaete 595, 600; **succineum**  
   645, 648; tetrasporum 646; **turgi-**  
   **dopilosum** 639, 648; **velutinum**  
   641, 648  
 Chalaropsis 634  
 Chlamydomys 53, 57, 228

- Chlorociboria aeruginascens* 210; *versiformis* 210  
*Chlorosplenium aeruginosum* 210; *chlora* 210  
*Chondrogaster* 39  
*Chondropodiella clethrincola* 214  
*Chrysocelis* 523, 525  
*Chrysospora gynoxidis* 524  
*Chytriumyces* 510, 513, 520-521; *aureus* 270; *hyalinus* 270; *stellatus* 270  
*Ciboria* 633  
*Ciborinia* 633  
*Cienkowskia reticulata* 146, 155  
*Cintractia* 87, 89; *albida* 264; *axicola* 264; *fimbristylis-kagiensis* 264; *leucoderma* 89, 264; *minor* 264; *pachyderma* 89; *suedae* 264; *ustilaginoides* 87-88  
*Cladochytrium aureum* 521; *replacatum* 270  
*Cladosporium* 19, 503, 634; *carpophyllum* 18; *dendriticum* 18; *epimyces* 18; *epiphyllum* 18-19, 214; *fulvum* 19; *glocosporioides* 214; *graminum* 19; *herbarum* 19; *typharum* 19  
*Clasterosporium caespitulans* 19; *Commonsii* 19; *populi* 19  
*Clastoderma Debaryanum* 146, 155  
*Clathrogaster* 42  
*Clathrus* 46  
*Claudopus* 633  
*Claustula* 44  
*Clavaria* 21, 633; *formosa* 210; *mutida* 213  
*Claviceps* 109-110, 633; *purpurea* 109, 126  
*Clitocybe* 633; *clavipes* 213; *illudens* 213  
*Clypeolella leemingii* 209  
*Clypeosphaeria* 111; *mamillana* 111; *Notarisii* 111  
*Coccidioides* 96, 319; *immitis* 317, 319  
*Coccomyces coronatus* 210  
*Coccosporium* 634  
*Cochliobolus* 247; *heterostrophus* 235  
*Cochlonema* 231, 239  
*Coleosporium elephanthopodis* 226; *helianthi* 211; *inconspicuum* 211; *oemleri* 211; *ribicola* 226; *solidaginis* 211, 215; *vernoniae* 212  
*Colletotrichum trichellum* 214  
*Collybia* 633  
*Colonnaria* 46  
*Colpoma azaleae* 210  
*Colus* 46, 282; *javanicus* 280; *Schellenbergiae* 280-281  
*Comatricha elegans* 162; *irregularis* 162; *laxa* 146, 162; *longa* 162; *longa var. flaccida* 162; *nigra* 162; *pulchella* 162; *Suksdorfii* 146; *typhoides* 146, 162  
*Conidiobolus* 633  
*Coniophora* 633  
*Coniosporium arundinis* 19  
*Coniostelium* 524; *quitensis* 524  
*Coniothyrium terricola* 559  
*Conocybe* 633  
*Cookeina* 649  
*Coprinus* 228, 633  
*Corditubera* 39  
*Cordyceps* 109, 310; *agariciformia* 110, 125; *australis* 306, 310; *capitata* 110, 126; *militaris* 109, 126, 209; *ophioglossoides* 209; *unilateralis* 308  
*Coriolus* 444, 633; *connatus* 452; *connatus ssp. obducens* 452  
*Cornuvia Serpula* 162  
*Coronophora ootheca* 121, 127  
*Corticium* 21-22, 86, 439, 633, 635-636; *coeruleum* 636; *portentosum* 439; *roseum* 213  
*Cortinaria rutila* 473; *viscida* 484; *viscida atropuncta* 475  
*Coryne sarcoides* 182  
*Coryneum ruborum* 363  
*Craterellus cornucopioides* 213  
*Craterium leucocephalum* 146, 153, 162  
**Crebrothecium** 184; **Ashbyi** 184-185  
*Cremeogaster* 39  
*Creopus gelatinosus* 117, 209  
*Crepidotus* 633  
*Cribraria* 141; *aurantiaca* 162; *elegans* 162; *intricata* 145, 153-154, 162; *minutissima* 162; *purpurea* 145, 157, 170; *tenella* 162; *vulgaris var. aurantiaca* 162  
*Cronartium pyriforme* 226; *quercuum* 212  
*Crucibulum* 55, 633; *vulgare* 214, 652, 659  
*Cryptocoryneum* 614-615  
*Cryptodiaporthes* 633  
*Cryptoporus volvatus* 362  
*Cryptosphaerella annexa* 121, 127  
*Cryptosphaeria* 111  
*Cryptospora* 114; *cinctula* 114, 126, 209  
*Cryptosporella* 114, 611; **acerina** 610, 619  
*Cryptovalsa* 111  
*Cucurbitodithis pithyophila* 209  
*Cucurbitaria calvescens* 572; *papa-veracea* 573  
*Curvularia* 618, 634

- Cyathus 55, 633; fascicularis 659; olla 655; stercoreus 652-655, 657-659; striatus 652, 657-659; vernicosus 652-659  
 Cyclomyces greenei 213  
 Cylindrosporium 606; acerinum 215; **corni** 630; oculatum 631; **saximontanense** 630; smilacinae 605, 613; veratrinum 605-606, 613  
 Cyphella 633  
 Cystobasidium 433  
 Cystogomphus Humboldtii 465  
 Cystopsora oleae 424, 426  
 Cytidia 633  
 Cytospora chrysosperma 227; pinastri 215  
 Dacrymyces 78, 80, 85, 633; corticioides 81; involutus 81; minor 212; palmatus 212  
 Dactylella 384; doedycoides 377; heterospora 377  
 Daedalea 633; confragosa 362  
 Daldinia concentrica 209  
 Darluca filum 215  
 Dasturella 284, 288-289  
 Dasyscypha nivea 210  
 Deconica 633  
 Delitschia Marchalii 595, 598  
 Dematium ramorum 19  
 Dendrina diospyri 19  
 Dendrodochium affinis 22; densipes 22; pezizoides 22; rubellum 22; serratum 22; succineum 22  
 Dendryphiella 620; interseminatum 621  
 Dendryphium 634; cladosporioides 602; nodulosum 621; pini 602, 603  
 Dentinum albidum 213; repandum 213  
**Dermatosorus** 267; **eleocharidis** 267-268  
 Dermea 66, 75; balsamea 210; puberula 210  
 Desmella superficialis 524  
 Desmotelium 525  
 Diachaea bulbilosa 146; leucopodia 162  
 Diaportha 112, 114; eres 112; leiphaemia *var.* raveneliana 209; oncostoma 114, 126, 209  
 Diatrype 111-112; asterostoma 209; disciformis 112; stigma 209  
 Diatrypella 111-112; favacea 209  
 Dibotryon morbosum 121, 127  
 Dictydiaethalium plumbeum 143, 145, 157-158, 162, 168  
 Dictydium cancellatum 145, 162, 170; cancellatum *var.* purpureum 162  
 Dictyobole texensis 225  
 Dictycephalus 52, 57, 227  
 Dictyophora 45  
 Dictyuchus 178, 685  
 Diderma effusum 162; floriforme 147; globosum 147, 163; radiatum 163; testaceum 163  
 Didymella 612  
 Didymium 147, 167, diffforme 163, 169; diffforme *var.* comatum 163; effusum 163; leucopus 165; Libertianum 163; melanospermum 163; nigripes 143, 163, 167-168; nigripes *var.* xanthopus 163; praecox 163; Serpula 163; squamulosum 147, 153, 163; xanthopus 147, 163, 170  
 Didymochlamys 87; ustilaginoides 87  
 Dietelia 284  
 Dimerium **alpinum** 609  
 Diplocystis 49  
 Discina 675; abietina 676  
 Disciseda 48; artocreas 215  
 Doassansia opaca 256  
 Dothichloe 109  
 Dothidea 105, 118, 127; collecta 113, 127; Sambuci 118  
 Dothiora subtropica 105, 126  
 Dothiorella magnifructa 606  
 Drosophila 633, 636  
 Durandiella fraxini 210  
 Echinodontium 633  
 Echinophallus 45  
 Echinostelium minutum 146, 153  
 Ectostroma oryzae 256  
 Ectrogella 33; **Besseyi** 30, 33, 35  
 Eichleriella 529, 633  
 Elaphomyces 209  
 Elasmomyces 41  
 Elateromyces 257; treubii 257  
 Elsinoe 209, 320-321, 633, 635-636; canavaliae 552; **Mattirolanum** 321, 322  
 Endocochlus 229-231, 235, 239; asteroides 229; **binarius** 232, 234, 236, 238, 240, 242, 245, 247-250; brachysporus 229; gigas 229, 239  
 Endoconidiophora 633  
 Endoptychum 56  
 Endothia 114, 633; parasitica 209  
 Enerthenema melanospermum 146; papillatum 146, 163  
 Enteridium 147; olivaceum 163; Rozeanum 141, 143, 145, 147, 150-151, 154, 156, 163, 168, 170  
 Entyloma 254-255, 700-701; alopecuri 252; australe 254; bavaricum 255; bidensis 254; calendulae 699; **eleocharidis** 255; microsporium 255; oryzae 256; parvum 255; senecionis 255  
 Eocronartium 427, 431, 433, 439; muscicola 440  
 Epichloe 109; typhina 110

- Epicoccum neglectum* 22; *negundinis* 22; *nigrum* 22; *purpurascens* 22; *scabrum* 22; *vulgare* 22-23  
*Epidermophyton* 634-635; Kauffmann-Wolf 291; *rubrum* 301  
*Eremothecium* 183, 636; *Ashbyi* 183-185; *Cymbalariae* 183, 185  
*Erionema aureum* 163  
*Erysiphe graminis* 496; *polygoni* 209  
*Eutypa* 111-112  
*Eutypella* 111-112; *fraxinicola* 112-126; *microcarpa* 209  
*Excipula pithya* 61  
*Exidia* 633; *nucleata* 212; *recisa* 212  
*Exosporium* 614-615, 618; **pedunculatum** 609, 617-618; *sambuci* 614, 617-618  
*Farysia* 257, 265; *caricis-filicinae* 265-266; *emodensis* 257; *merrillii* 265; *olivacea* 265; *pseudocyperi* 265  
*Favolus* 633  
*Femsonia* 633  
*Fimetaria* 597  
*Fistulina* 633; *hepatica* 213  
*Flammula* 633  
*Floccomutinus* 45  
*Fomes* 442-444, 448, 452, 454-455, 633; *applanatus* 213; *connatus* 443-444, 452; *fomentarius* 455; *lucidus* 19; *meliae* 452; *officinalis* 443; *oxyporus* 452; *populinus* 443, 452  
*Fomitiporia* 633  
*Fomitopsis* 443, 450, 455; *connata* 452  
*Fonsecaea* 96  
*Fracchiacea heterogena* 121, 127  
*Frommea obtusa* 212  
*Frostiella* 491  
*Fuligo septica* 144, 146, 157, 159, 164, 170, 208  
*Funalia mons-veneris* 452  
*Fusarium* 23, 411, 414, 634, 636; *aurantiacum* 23; *episphaericum* 23; *granulosum* 23; *nivale* 494; *rimosum* 23; *roseum* 23; *Schweinitzii* 23  
*Fusella polyporina* 19  
*Fusicladium dendriticum* 19; *staticis* 19  
*Fusidium cana* 15  
*Fusisporium episphaericum* 23; *rimosum* 23  
*Galactinia michelii* 210  
*Galera* 633  
*Galerina* 633  
*Galeropsis* 56  
*Ganoderma* 633; *Curtisii* 227  
*Gasterella* 39  
*Gasterellopsis* 39  
*Gastrosporium* 42, 58  
*Gautieria* 41  
*Geaster* 57, 227 (= *Geastrum*, *a.v.*)  
*Geastroides* 50  
*Geastrum* 50 (see *Geaster*)  
*Gelopellis* 44; *hahashimensis* 44  
*Geoglossum glabrum* 210; *simile* 210  
*Gibberella* 411, 414, 415, 633, 636; *lateritium* 411-412, 415; *roseum* 411-412, 415; *zeae* 209  
*Gibellula* 304, 306-307; **formicarum** 309-310  
*Glenospora Curtisii* 19  
*Gliocladium* 634  
*Gliomastix* 634  
*Glischroderma* 52  
*Gloeocystidium* 633  
*Gloeosporium* 440; *bolleyi* 494; *caryae* 215; *graminum* 494; **meinersii** 494; *meinersii var. alpina* 494  
*Gloeotulasnella* 633  
*Glonium abbreviatum* 210  
*Glutinium macrosporum* 363  
*Gnomonia* 114, 209; *setacea* 209  
*Gnomoniella* 114  
*Godronia rugosa* 210; *urceolata* 210  
*Gomphidius* 475, 489; *alabamensis* 473; *alachuanus* 470; *flavipes* 475, 477; *foliiporus* 489; *furcatus* 475, 477; *glutinosus* 462, 479, 481-484, 487-488; *glutinosus f. maculans* 488; *glutinosus f. maculosus* 485; *gracilis* 475; *jamaicensis* 470; *leptocystis* 463, 465-467, 471; *litiginosus* 473; *maculatus* 463, 475, 477-478, 488; *maculatus var. furcatus* 477; *maculatus f. gracilis* 475; *maculatus ssp. gracilis* 475; *maculatus var. gracilis* 475; *nigricans* 478, 480, 488; *ochraceus* 468, 471; *ochraceous ssp. muscigenus* 472; *ochraceous ssp. superiorenensis* 472; *ochraceous ssp. typicus* 471-472; *oregonensis* 486-488; *rhodoxanthus* 489; *roseus* 488; *rutilus* 468, 473-474; *rutilus ssp. alabamensis* 473, 475; *rutilus ssp. typicus* 474; *rutilus ssp. typicus var. testaceus* 474; *septentrionalis* 478-479, 488; *sibiricus* 468; *Smithii* 479, 481, 488; *Smithii var. xanthobasis* 482; *stilatus* 475, 488; *subroseus* 479, 482, 485, 487-488; *subroseus var. homobasis* 482, 484, 488; *superiorenensis* 472; *testaceus* 473; *tomentosus* 463-468; *vinicolor* 468; *vinicolor ssp. californicus* 470; *vinicolor ssp. jamaicensis* 470; *vinicolor ssp. typicus* 470; *vinicolor var. minor* 480; *viscidus* 473-474, 485; *viscidus var.*

- columbiana 473-474; viscidus *var.* testaceus 472  
 Goplana 431, 434  
 Grandinia 86, 633  
 Graphium hamamelidis 215  
 Grossmannia 633  
 Guepinia spathularia 212  
 Guepiniopsis 80; andinus 80  
 Guignardia Bidwellii 119; galactina 209  
 Gymnoglossum 40  
 Gymnosporangium 217, 224, 226, 228, 420, 426; clavipes 420-421, 424-426; cupressi 227; juniperi-virginianae 212; nidus-avis 212  
 Gymnosporium arundinis 19  
 Gyrophragmium 56  
 Gyroporus castaneus 214  
 Hadrotrichum Populi 320; Populi *f.* Arbuti 322  
 Hainesia borealis 608, 613; lythri 608  
 Haplophragmium milletiae 523-524  
 Harposporium helicoides 235  
 Helicobasidium 439  
 Helicocephalum 247; oligosporum 235  
 Helicogloea 427, 435, 437, 439-440, 633; **alba** 435, 436, 439-440; caroliniana 440-441; contorta 439; indica 438; pinicola 440-441; Sebacinioidea 97  
 Helicoma 564, 634; curtisii 563  
 Helminthosporium 20, 202-203, 206, 215, 247, 355, 563, 568, 593, 614, 619-621, 634, 636; arctisporum 19; **buchloes** 203-204; gramineum 593; hadotrichoides 19, 21; inconspicuum 202, 204-205; inconspicuum *var.* Buchloes 202, 204; interseminatum 19, 620-621; macrocarpum 19; persistens 20; pirorum 20; tiliacae 20; turcicum 203, 205; vagans 497; variegatum 20; vigneae 355; **vignicola** 355; vimineum *var.*  $\gamma$  621  
 Helotium caudatum 210; virgultorum 211  
 Hemiarcyria rubiformis 164  
 Hemitrichia clavata 145, 164; Serpula 145, 164; stipata 164; stipitata 145; Vesparium 141, 145, 164  
 Hendersonia culmicola *var.* minor 497, 499-500; heloniaefolia 215  
 Hercospora 114  
 Hericium 633  
 Herpobasidium 427, 433-435, 439; filicinum 440  
 Herpotrichia nigra 610  
 Heterochaete 527-529; andina 527-529, 531, 534-535; Burtii 533; **crassa** 529-531, 533; gelatinosa 528; Shearii 527-529, 532, 534-535; sublivida 527, 529, 533-535  
 Heteroporus 444  
 Heterosporium 614, 620-621, 634; sambuci 621  
 Hirneola 633  
 Hirsutella 304, 306-307, 309; **confragosa** 306; formicarum 308; **liberiana** 306, 308, 310; **ramosa** 308-310  
 Histoplasma capsulatum 317-319  
 Holocotylon 38, 40  
 Hormiactella 634  
 Hormiscia tetraciliata 362  
 Hormodendron 96  
 Humaria scutellata 211; setosa 211; umbrorum 211  
 Humicola 278-279, 634; fusco-atra 278-279; grisea 278-279  
 Hyaloscypha atomaria 211  
 Hydnangium 41  
 Hydnum 528, 633, 636; fennicum 213  
 Hymenochaete 528, 633; arida 213; corrugata 213; fuliginosa 213  
 Hymenogaster 39-40  
 Hymenopsis trochiloides 23  
 Hymenostilbe 310  
 Hypholoma 633  
 Hypochniella 218  
 Hypochnus 633  
 Hypocrea 100, 117, 209; gelatinosa 117; lenta 117, 127; patella 209  
 Hypoderma commune 209, 211  
 Hypodermopsis smilacis 209  
 Hypomyces 100, 117, 414; chrysospermus 209; hyalinus 209; lactiflorum 117; solani 411, 414-415; solani *f.* cucurbitae 411, 414-415  
 Hypoxylon 12; cohaerens 209; fuscum 209; microplacum 209; multiforme 209; punctulatum 209; rubiginosum 209; serpens 209; tinctor 110, 126  
 Hysterangium 43  
 Hysterium 122; acuminatum *var.* alpinum 608-609; pulicare 122  
 Hysterographium flexuosum 122, 127, 580-581; graminis 580; **hysterioides** 581  
 Illosporium Mattirolinum 320, 322; pallidum 23; panduratum 23  
 Inonotus amplexans 703  
 Irpex 444, 633  
 Isariopsis clavispora 215  
 Isoachlya 178  
 Itajahya 45, 57, 228  
 Iteronilia 686-689, 699-701; perplexans 688-689, 699; **pyriformis** 689, 696-697, 699-700  
 Ithyphallus 634, 636

- Jaczewska 43  
 Jansia 45  
 Jola 427-428, 431, 433-434, 439;  
   javanensis 440  
 Kabatia 629; **fragariae** 628-629;  
   latemarensis 629; lonicerac 629;  
   mirabilis 629  
 Kalchbrennera 47  
 Karlingia 270, 505, 507, 512, 516,  
   519-521; **asterocysta** 506, 509-  
   511, 519; 521-522; **chitinophila**  
   506, 508, 519, 521-522; **curvispi-**  
   **nosa** 506, 509, 511, 519, 521-522;  
   **dubia** 506, 509, 513, 515, 519, 521-  
   522; granulata 270, 506, 515-520;  
   hyalina 270, 506, 508-509, 518-  
   519; **lobata** 506, 515, 518-522;  
   **marylandia** 506, 515, 518-522;  
   rosea 270-271, 275-276, 505-509,  
   519, 521; spinosa 508-509, 519  
 Karstenula 589; carpinicola 588  
**Kernella** 97, **Lauricola** 97  
 Kernia 97  
 Kuehneola uredinis 212  
 Kuntzeomyces 87; ustilaginoides 89  
 Lachnum cerinum 211; ciliare 211;  
   spiraeacolum 211; virgineum 211  
 Lactarius subpurpureus 213; volemus  
   213  
 Lagenidium Closterii 275; Distylae  
   274; humanum 274-276; pyg-  
   maeum 275  
 Lambertella 633  
 Lamproderma arcyrionides 164; arcyr-  
   ionema 146, 164, 170; columbinum  
   164; Sauteri 146, 170; scintillans  
   146, 170; violaceum 164  
 Lanopila 49  
 Lasiosphaeria 564; ovina 121, 127;  
   pezizula 563  
 Laternea 46  
 Leccinum chromapes 214; nigrescens  
   214; rubro-punctum? 214; rugosi-  
   ceps 214; scabrum 214  
 Lentinus 633  
 Lenzites 633; betulina 213; saepiaria  
   213, 362  
 Leocarpus fragilis 142-143, 146, 157,  
   164, 170; vernicosus 164  
 Leotia lubrica 211; viscosa 211  
 Lepidoderma tigrinum 157, 164  
 Lepiota 633  
 Leptogorgia 178  
 Leptonia 40  
 Leptoporus 633; connatus 452  
 Leptosphaeria 119, 125, 571, 578, 583,  
   593; aerea 583, 592; obtusispora  
   592; ogilviensis 209; vagabunda  
   209  
 Leptothyrium macrothecium 608  
 Le Ratia 40  
 Leucogaster 38-39  
 Leucophleps 38-39  
 Licea pannorum 165  
 Lindbladia effusa 141, 145, 154, 164  
 Linospora 114; populina 114  
 Liroa 257, 259; emodensis 257  
 Longula 56  
 Lophionema 625; **apoclastospora**  
   624-625, 631; bambusae 625; cho-  
   dati 625; cylindrosporium 625; im-  
   plexum 625; vermisporium 625  
 Lophiostoma insidiosum 583  
 Lophodermium nitens 211; pinastri  
   211; rhododendri 209  
**Lophotrichus** 347, 352-353; **ampul-**  
**lus** 347-348, 351-354; **martinii**  
   349-354  
 Lycogala 142, 147; epidendrum 22,  
   145, 147, 150, 154, 157, 164; flavo-  
   fuscum 164; flavo-fuscum var.  
   solida 164; miniatum 164  
 Lycogalopsis 49  
 Lycoperdon 48, 57, 633; atropur-  
   pureum 214; echinatum 214; gem-  
   matum 214; pyriforme 214; subin-  
   carnatum 214  
 Lycoperdopsis 48  
 Lysurus 46  
 Maccagnia 39  
 Macrophoma smilacis 215  
 Macropodia macropus 211  
 Macrosporium 20, 617, 634; avicen-  
   nae 20; commune 20; cydoniae 20;  
   herculeum 20; iridis 20; macula-  
   tum 20; maydis 20; nobile 20  
 Magnusia 97  
 Mainsia epiphylla 524  
 Mamiania 114  
 Marasmius 213, 633  
 Maravalia 523, 525; achroa 523-524  
 Massaria 633, 635; Argus 121, 127  
 Massarina 612; corni 612; eburnio-  
   ides 612; pomacearum 612  
 Massarinula 612; **lignorum** 611-612,  
   619  
 Massariovalsa 114, 633; sudans 114  
 Masseella 290  
 Mehtamyces stereospermi 524  
 Melampsora 283, 525; abietis-caprae-  
   arum 212  
 Melanconis 114, 633, 635  
 Melanogaster 39  
 Melanoleuca 633  
 Melanomma pulvis-pyrius 209  
 Melanopsichium pennsylvanicum 263  
 Melanospora 353; destruens 195-196  
 Melascypha 649  
 Meliola 100; circinans 125



- Memmoniella 634  
 Merulius 80, 633  
 Mesophellia 50  
 Metarrhizium 634  
 Metasphaeria 209, 612  
 Microsphaera Alni 106, 126, 209;  
   alni vaccinii 210  
 Microsporium 634  
 Mollisia caesia 211; cinerea 211  
 Monascus 633  
 Monilia aurea-fulva 13  
 Monochaetia desmazierii 215  
 Monosporium 80  
 Monotopora 277, 279, 634; daleae  
   279; megalospora 215  
 Montagnea 56  
 Morchella 633  
 Morenoella quercina 122, 125  
 Morganelia 48  
 Mucidula 633  
 Mucilago spongiosa 147, 165  
 Mucor 633  
 Mucronella 633  
 Mutinus 45; caninus 367  
 Mycena 633  
 Mycenastrum 47, 49; corium 227  
 Mycoacia 633  
 Mycogone puccinioides 277  
 Mycosphaerella 105, 118, 127, 210;  
   effigurata 119, 127; leucothoes 210;  
   rubina 363  
 Myriocopron smilacis 122, 125, 210  
 Myriangina 547-548; mirabilis 547,  
   552; sabaleos 548  
 Myrianginella 547-548, 550, 552;  
   **sabaleos** 550, 552; tapirae 546-  
   547, 550  
 Myriangium 125, 544-546, 548-549,  
   552; Duriaci 106, 126, 210; saba-  
   leos 537-538, 543-545, 548, 550  
 Myriostoma 50  
 Myrothecium 634; inundatum 23  
 Myxosporium 634; corticola 363  
 Myxotrichella 634  
  
 Napicladium 619  
 Naucoria 634  
 Nectria 100, 117, 411-415; bicolor  
   23; cinnabarina 117, 210; coccinea  
   117, 127, 210; episphaeria f. cocco-  
   phila 411, 415; galligena 117, 127;  
   ochroleuca 117, 210; Ribis 117  
 Nectriella rousseliana 210  
 Nematotonus 369-370; **concurrans**  
   371, 374, 378, 381-382, 384-387;  
   haptocladus 369-370, 372-373, 376,  
   379-380; leiosporus 369; leptos-  
   porus 369; pachysporus 369, 373,  
   375; tylosporus 369  
 Nematospores 183  
 Neopeckia coulteri 610  
  
 Neovossia horrida 254  
 Nereocystis luetkeana 362  
 Neurospora 633; crassa 414; tetra-  
   sperma 414  
 Nidula 54  
 Nidularia 54; pisiformis 652  
 Nidulariopsis 55  
 Nigrospora 634  
 Nowakowskiella crassa 521; elegans  
   270  
 Nyctalis 634-635  
  
 Ocellaria ocellata 211  
 Odontia 528, 634  
 Oedocephalum 563  
 Oidium megalosporum 13; simile 13  
 Oligonema flavidum 165; Schweinit-  
   zii 145, 157, 170  
 Olivea 523, 525  
 Olpidiopsis 32-33, 270-271, 273, 276,  
   511, 521; Achlyae 275; ?Aphanom-  
   mycis 275; **Karlingiae** 271-272,  
   275-276; Pythii 275; Schenkiana  
   28-30, 31-35; Sphaeritae 271;  
   vexans 273  
 Olpidium Rhizophlyctidis 271  
 Omphalia 634  
 Ophiobolus 247, 633; heterostrophus  
   247  
 Ophiodothella 114; Ingae 114; vac-  
   cimii 210  
 Ophiostoma 633  
 Orbilia curvatispora 211; inflatula  
   211; leucostigma 211; luteo-ru-  
   bella 211; xanthostigma 211  
 Otidea 660-662, 664, 675-676; abie-  
   tina 663, 675, 677; alutacea var.  
   **microspora** 660, 663, **668**-669;  
   alutacea var. typica 663, 667-669,  
   677; auricula 660-663, 669-671,  
   677; Cantharella var. minor 661,  
   663, 667; concinna 662, 666; felina  
   668-669; fibrillosa 661; grandis  
   62-663, 668, 672, 677; **Kauffmanii**  
   660, 663, **673**, 677; leporina 660,  
   662, 666-667, 673; leporina var.  
   minor 662, 664; leporina var.  
   typica 662-664, 677; neglecta 662,  
   670; onotica 660, 662, 665-666,  
   677; **rainierensis** 660, 663, **674**,  
   677; Smithii 662, 671, 677; um-  
   brina 662, 673  
 Otthia hypoxylon 210  
 Ovularia pusilla 496  
 Oxydantia 634, 636  
 Oxyporus 443-444; nobilissimus **444**-  
   445, 447-449, 451, 454-455; ob-  
   ducens 444, 452; populinus 444-  
   445, 448, 452, 454-455; populinus  
   var. obducens 452; ravidus 443-  
   444



- Panaeolina* 634  
*Panaeolus* 634  
*Panellus* 634  
*Panus* 634; *stypticus* 213  
*Patellaria atrata*  $\beta$  62, 72; *pithya* 61, 68  
*Patinella fragariae* 608  
*Paxillus* 634  
*Peckiella viridis* 210  
*Pellicularia* 634  
*Penicillium* 405, 634, 636; *camemberti* 215; *chrysogenum* 388, 405, 410; *notatum* 388, 403, 408-410; *thomii* 215  
*Peniophora* 634; *sambuci* 636; *sanguinea* 213; *subalba* 213  
*Perichaena chrysosperma* 145; *corticis* 165; *depressa* 145, 165  
*Perichlamys* 87  
*Periconia* 416-417; *byssoides* 20; *circinata* 416-419; *heveae* 417; ***macrospinosus*** 417-419; *minutissima* 20; *pynospora* 20-21  
*Peridermium* 226; *cerebrum* 226; *fusiforme* 226; *pyriforme* 226  
*Peronospora* 197, 201, 329, 333, 338; *Alsinearum* 329; *alta* 326-328; *candida* 328; *deBaryi* 198-201, 331; *destructor* 330-331; *effusa* 327, 329; *entosporea* 325; *farinosa* 329; *Ficariae* 329; *gangliiformis* 326; *ganglioniformis* 326; *Geranii* 333; *grisea* 330; *Hepaticae* 334; *Illinoensis* 334; *Kellermanni* 325; *nivea* 334; *obovata* 330; *parasitica* 330; *Plantaginis* 327-328; *Potentillae* 330; *pygmaea* 334; *ribicola* 334-335; *Schleideni* 331; *Schleideniana* 330-331; *tabacina* 201, 338; *Urticae* 197-199, 331, 333; *viticola* 336-337  
*Pestalopezia rhododendri* 211  
*Pestalotia* 634; *funerea* 215  
*Petersenia* 32  
*Peyronelia sirodesmoides* 601, 603  
*Pezicula* 211; *alnicola* 211; *carnea* 211  
*Peziza* 660, 675; *abietina* 660, 675; *badia* 211, 676; *cochleata* 660; *leporina* 660; *oenotherae* 608; *onotica* 660, 673; *vesiculosa* 182  
*Pezizella lythri* 211, 608  
*Phaeolus* 634  
*Phaeopeltosphaeria* 585; *caudata* 585  
*Phakopsora* 283-285, 287-290; *Ampelopsidis* 288; *antiguensis* 289; ***Burserae*** 287, 289; *Cherimoliae* 289; *desmum* 289; *dominicana* 283; *fenestrala* 289; *Hansfordii* 286; *jatrochicola* 289; *melaena* 285-286; *Meliosmae* 287; *punctiformis* 283; *Randiae* 285-286; *tecta* 289; *venezuelana* 287; *vitis* 288  
*Phallogaster* 43  
*Phallus* 45, 634, 636  
*Phaneroconium* 615  
*Phellinus* 634  
*Phellorinia* 53, 228  
*Phialea temulenta* 494  
*Phialophora* 96, 634; *verrucosa* 317  
*Phillipsia* 649  
*Phlebia* 634; *strigosozonata* 635  
*Phleospora graminivora* 628; *idahoensis* 628; ***muhlenbergiae*** 628  
*Phlyctidium* 218  
*Phlyctothiza variabilis* 270  
*Pholiota* 634; *caperata* 213  
*Phoma* 20, 498, 503, 634; *magnifructa* 606; *pustulata* 218  
*Phragmidium* 217; *imitans* 363; *rubidaei* 687, 700  
*Phragmodiaporthe* 126  
*Phycomyces* 633  
*Phyllachora* 114-115, 502, 538; *graminis* 13, 109, 114-115, 127; *Lespedezae* 109, 115, 126, 210; *punctum* 210  
*Phylloporus rhodoxanthus* 213, 489; *rhodoxanthus ssp. foliiporus* 489  
*Phyllosticta* 498, 628; ***alpinicola*** 625; *antennariae* 627; *bonansiana* 626; ***crustosa*** 607-608, 613; *epigaeae* 215; *ignatiana* 626; *medicaginis* 626; *melanoplaca* 605; ***minutaspora*** 497, 503; ***ragnhildae*** 626; ***smilacinae*** 627; *trifolii* 626; *trifolii-minoris* 626; *vagans* 628; *woronowii* 628  
*Physalacria* 439  
*Physarella oblonga* 146, 157-158, 165, 170  
*Physarum albescens* 165; *albipes* 165; *album* 163; *bivalve* 165; *cinereum* 146, 157, 165; *compressum* 165; *connatum* 165; *contextum* 146; *crateriforme* 165; *didermoides* 146, 165, 170; *digitatum* 165; *flavicomum* 146, 152, 154-155, 165, 170; *fulvum* 165; *globuliferum* 146, 165; *leucophaeum* 165; *leucopus* 165; *lividum* 165; *macrocarpum* 161; *melleum* 146, 155, 170; *notabile* 165; *nucleatum* 165; *nutans* 146, 165; *polycephalum* 143-144, 146, 165, 168; *pulcherrimum* 165; *ruginosum* 161; *Serpula* 165; *sinuosum* 165; *straminipes* 165; *Tussilaginis* 163; *virescens* 166; *viride* 146, 166, 170  
*Physisporinus obducens* 452

- Physoderma 521; *zeae-maydis* 514  
 Physopella 287; *Burserae* 287;  
*Cherimoliae* 287; *desmum* 287  
 Phytomonas sepedonica 179  
 Phytophthora 633; *infestans* 197  
 Piricularia grisea 13; *grisea var.*  
*parasitica* 13  
 Pirogaster 52  
 Pisolithus 52  
 Pithya 649  
 Pityrosporum ovale 96  
 Plasmopara 325, 335; *Acalyphae* 332,  
 333; *Geranii* 333-334; **Hepaticae**  
**334**; *Illinoensis* 334; *Kellermani*  
 325; *nivea* 334; *pygmaea* 324, 334;  
*ribicola* 332, 334-336; *Viburni* 332,  
 336; *viticola* 336-337  
**Platycarpa** 427-428, 431, 433-434,  
 439; **boliviensis** 428-429, 432, 439-  
 440; **Polypodii** 428, 430-433, 439-  
 440  
 Platygloea 435  
 Plectania 649; *coccinea* 180-182  
 Pleosphaeria 571-572; *hyphasmatis*  
 570, 593  
 Pleospora 105, 565, 569-570, 579,  
 581-585, 593; *Amelanchieris* 587,  
 589, 592-593; *Andropogonis* 580;  
*atromaculans* 579, 587, 591, 593;  
*aurea* 121, 127; *Avenae* 567-568;  
*Bardanae* 574, 586, 592; *Boldoae*  
 566, 585-586, 591, 593; *Bromi* 567-  
 568; *calvescens* 570, 572, 575, 578,  
 590, 593; *calvescens f. papaveracea*  
 590; *carpinicola* 583, 588-589, 591;  
*cereicola* 581, 583, 592; **clypeata**  
**584**-585, 587, 593; *coronata* 592;  
*culmorum* 567, 570, 592; *diapor-*  
*thoides* 566, 574, 579, 581-583, 585,  
 587-590, 592-593; *donacina* 577;  
*findens* 577-579, 587, 591, 593;  
*Forsteri* 576-577, 591; *fuegiana*  
 576-577, 591; *graminea* 567-568;  
*herbarum* 125; *hysterioides* 580,  
 590-591; *Juglandis* 588-589, 591;  
*lactucicola* 566, 583, 585-586, 589-  
 591, 593; *Lecanora* 574, 591; *media*  
 585; *microspora* 577; *minuta* 591;  
*mollis* 566-567, 570, 591, 593; *oli-*  
*gostachyae* 566, 579-582, 585, 590,  
 593; *papaveracea* 573-574, 590,  
 592; *parvula* 578, 591; *pellita* 566,  
 572-575, 578-580, 582, 584, 590,  
 593; *polytricha* 567; *relicina* 567,  
 592; *sarcocystis* 570; *Shepherdiae*  
 587-589, 592-593; *tenuis* 591-592;  
*teres* 567-568; *Thuemeniana* 584-  
 585, 591-592; *trichostoma* 566-568,  
 575, 587, 593; *trichostoma f. sp.*  
*Bromi* 567; *trichostoma f. sp.*  
*Hordei erecti* 567; *trichostoma f.*  
*sp. Tritici-repentis* 567; *Tritici-*  
*repentis* 567-568; *typhicola* 570;  
*vagans* 575-579, 585, 587, 593;  
*vagans var. Airae* 577; *vagans*  
*var. arenaria* 576-578; *vagans var.*  
*pusilla* 576-577; *vagans var. Spar-*  
*ganii* 577; *vulgaris* 585  
 Pleurage 598; *albicans* 210; *collapsa*  
 595, 598; *decipiens* 598; *superior*  
 597  
 Pleurophomella 67; *eumorpha* 67  
 Pleurotus 634  
 Pluteus 634  
 Pocosphaeria 571  
 Podaxis 55-56  
 Podosporium rigidum 21  
 Podostroma 117  
 Pogonomyces hydnoides 452  
 Polyactis streptothrix 12  
 Polymyxa graminis 169  
 Polyporus 14, 18, 86, 443, 634; *abie-*  
*tinus* 213; *adustus* 213; *berkeleyi*  
 213; *cinnabarinus* 213; *cinnamo-*  
*meus* 213; *connatus* 452; *cremeus*  
 452; *dryadeus* 226-227; *dryophilus*  
 226; *elegans* 213; *farlowii* 228;  
*focicola* 213; *giganteus* 213; *hir-*  
*sutus* 213; *lucidus* 362; *meliae* 452;  
*neesii var. connatus* 452; *obducens*  
 452; *oxyporus* 452; *pargamensis*  
 213; *perennis* 213; *populinus* 443,  
 452; *sulphureus* 213; *tulipiferus*  
 213; *ulmarius* 452; *versicolor* 77-  
 78, 213  
 Polyscytium sericeum 13  
 Polystictus 454, 634; *populinus var.*  
*connatus* 454; *xanthopus* 454  
 Polystigma rubrum 115  
 Polythrincium trifolii 21  
 Pompholyx 52  
 Pontisma 32  
 Poria 213, 455, 634, 636; *isabellina*  
 213; *obducens* 443-444, 452, 454;  
*versipora* 213  
 Porphyrellus gracilis 214  
 Pragmopora amphibola 59; *bacil-*  
*lifera* 59  
 Pratella 217  
 Propolidium glaucum 211  
 Prosopodium 525-526; *perodiosum* 524  
 Protodontia 529  
 Protogaster 38, 58  
 Protohydnum 529  
 Protomyces 324; *fuscus* 324; *grami-*  
*nicola* 324  
 Protuberia 43  
 Psalidosperma 563  
 Psalliota 217, 634  
 Pseudocolus 46, 282; *Schellenbergiae*  
 282  
 Pseudocoprinus 634

- Pseudolpidium* 521; *Sphaeritae* 271  
*Pseudoperonospora* 533; *Humuli* 199;  
*Urticae* 198, 201, 331, 333  
*Pseudoplectania* 649  
*Pseudopleospora* 581; *ruthenica*? 581  
*Pseudotis* 675  
*Pseudotrichia* 119, 126  
*Pseudovalsa* 114; *sigmoidea* 114  
*Psilopezia* 80  
*Ptychogaster* 634  
*Puccinia* 217, 225, 523, 617; *andro-*  
*pogonis* 226; *angustata* 212; *are-*  
*nariae* 424; *bolleyana* 212; *bottom-*  
*leyae* 523; *coronata* 212; *cynodon-*  
*tis* 524; *ellisiana* 226; *helianthi*  
212; *malvacearum* 688; *menthae*  
212; *mesomajalis* 212; *oxalidis*  
227; *polygoni* 524; *rubigo-vera*  
*var. impatientis* 212; *smilacis* 212;  
*solmsii* 523; *tenuis* 212; *violae* 212  
*Pucciniastrum hydrangeae* 212; *myr-*  
*tilli* 212  
*Pullularia* 67, 634  
*Pulveroboletus auriflammeus* 214;  
*auriporus* 214; *ravenelii* 214; *re-*  
*tipes* 214  
*Pyrenochaeta* 633  
*Pyrenophora* 218, 247, 568, 571-572;  
*Bromi* 568; *calvescens* 572; *delica-*  
*tula* 570-571, 590-591, 593; *echi-*  
*nella* 572; *hyphasmatis* 570, 572,  
590; *pellita* 573, 590; *relicina* 567;  
*Teres* 567-568; *trichostoma* 567;  
*Tritici-repentis* 567-568  
*Pythiella* 33; *vernalis* 33, 275  
*Pythiomorpha* 633  
*Pythiopsis* 178  
*Pythium* 33-34, 171, 173-174, 176,  
245, 274-275, 521, 633; *aphanider-*  
*matum* 171; *butleri* 636; *catenula-*  
*tum* 171; *complexans* 171; *debary-*  
*anum* 171; *dissotocum* 171; *gracile*  
171; *helicoideis* 174, 636; *inflatum*  
171; *irregulare* 171, 370; *mamil-*  
*latum* 229, 245; *marsipium* 174;  
*monospermum* 171; ***multisporum***  
171-172, 174-175; *nagii* 174; *oedo-*  
*chilum* 174; *palingenes* 174; *poly-*  
*sporum* 173; *polytylum* 174; *pro-*  
*liferum* 174; *pulchrum* 171, 174;  
*splendens* 171; *tenuis* 171; *torulo-*  
*sium* 171; *ultimum* 171; *vexans* 171  
*Quaternaria* 111  
*Queletia* 53  
*Radiigera* 50  
*Radulum* 634  
*Ramularia* 603-605; *andromedae* 13;  
*arvensis* 13; *barbareae* 13; *cana*  
15; *celastri* 13; ***claytoniae*** 604,  
617; *decipiens* 13-14; *heraclei* 13;  
*macrospora* 13; *mimuli* 603; *obo-*  
*vata* 13; *orontii* 13; ***pentstemonis***  
**604**, 617; *plantaginis* 13; *pratensis*  
13-14; *ranunculi* 14; *Tulasnei* 14;  
*Ravenelia* 223, 225-227, 524-525  
*Reticularia Lycoperdon* 141-142, 145,  
147, 150-151, 153, 157, 166, 170;  
*umbrina* 166  
*Rhinotrichum Curtisii* 14; *ramosissi-*  
*imum* 14  
*Rhizidium* 520  
*Rhizoctonia* 634  
*Rhizophlyctis* 505, 520; *rosea* 505  
*Rhizopodella* 649  
*Rhizopogon* 40, 358; *diplophloeus* 358  
*Rhizopus* 633  
*Rhodopaxillus* 636  
*Rhodophyllus* 40  
*Rhopalogaster* 42-43  
*Rhopalophlyctis* 521  
*Rhynchosporium orthosporum* 496  
*Rhytisma acerinum* 211; *andromedae*  
211; *decolorans* 211; *salicinum*  
211; *vaccinii* 211  
*Richoniella* 40  
*Rosellinia* 111; *clavariae* 210  
*Russula crustosa* 213; *emetica* 213;  
*foetans* 213; *variata* 213; *virescens*  
213  
*Rutstroemia* 633; *macrospora* 211  
*Saccobolus Kerverni* 596  
*Saprolegnia* 178, 402, 684  
*Sarcoscypha* 649  
*Sarcosoma* 649  
*Schizophyllum* 634; *commune* 213,  
364  
*Schizospora* 290  
*Schizostoma* 53, 57, 228  
*Schizoxylon* 211  
*Scleroderma* 52; *geaster* 214; *lyco-*  
*perdoides* 214  
*Scleroderris* 64; *hypopodiza* 70  
*Sclerogaster* 41  
*Sclerospora graminicola* 324  
*Sclerotinia* 633  
*Sclerotiopsis concava* 608  
*Sclerotium* 634  
*Scodellina* 660  
*Scolecotrichum graminis* 21, 499,  
503-504  
*Scopella* 523-526; *baubiniicola* 524;  
*cryptostegiae* 523-524; *echinulata*  
523-524; *lucumae* 524  
*Scopellopsis* 523-525; *dalbergiae* 524  
*Scopulariopsis* 634  
*Sebacina* 532, 634, 636; *cinerea* 636;  
*incrusters* 212; *podlachica* 212;  
*Shearii* 532  
*Secotium* 56

- Sedecula 52  
 Selenophoma linicola 606, 617  
 Sepedonium 277; brunneum 215; chrysospermum 14, 215  
 Septobasidium 90, 427-428, 431, 434, 437, 439-440; album 427, 435, 437, 439; Polypodii 427-429, 431  
 Septochytrium plurilobulum 517, 521; variable? 270  
 Septocylindrium concomitans 215  
 Septonema spilomeum 21  
 Septoria 215, 607; agropyrina 502; aromatica 606, 617; avenae 498-499, 502; avenae f. *sp.* triticea 499; brevispora 365; calamagrostidis 498; cornicola 215; jaculella 498; lunelliana 606, 617; nodorum 499; oudemansii 499; secalis 499; secalis var. stipae 499; tritici 493; violae 215  
 Septosporium fuliginosum 21; hadotrichoides 21  
 Simblum 46, 57, 227  
 Solenia 634; anomala 213; fasciculata 213  
 Sorataea amiciae 523  
 Sordaria 111; appendiculata 210, 595, 597; decipiens 595, 597; fimicola 186, 194, 196, 597; vestita 595, 598  
 Sorosporium 268; andropogonis-aequali 266; digitariae 267; flagellatum 266; formosanum 252, 266-267; overeimi 266; paspalithunbergii 267; punctatum 266-267; tanganykanum 257; tanganyikanum 266; yoshinagae 266  
 Sparassis 634  
 Spermothora 183-184; Gossypii 184-185  
 Spermospore 495; subulata 495; subulata f. *ciliata* 495  
 Sphaeloma 320-321, 634-636; Mat-tirolanum 320-322; plantaginis 215  
 Sphaelotheca 262; cruenta 261; hydropiperis 262; *isachnes* 262; polygoni-senticosi 262; reiliana 262; sorghi 262; tanglinensis 263  
 Sphaeria 218; calvescens 572; cul-morum 567; Dematium 572; Papa-veris 573; pellita 573-574, 590; polytricha 567; relicina 567; tri-chostoma 567  
 Sphaerobolus 55, 634  
 Sphaerographium 215  
 Sphaeropsis 634; malorum 363  
 Sphaerosporium lignatile 23  
 Sphaerostilbe auranticola 103, 117, 125  
 Sphaerulina mappiae 182  
 Sphenospora kevorkianii 424, 426, 524; yurimaguasensis 524  
 Spicaria longipes 303-304; **pulvi-nata** 305  
 Spongipellis 634  
 Spongospora subterranea 169  
**Sporidiobolus** 686-689, 699-700; **Johnsonii** 686-687, 689-696, 698-700  
 Sporobolomyces 686-687, 690, 695, 698-699, 701; alborubescens 695; albus 695; gracilis 695; odoratus 695; pararoseus 695; pollaccii 695; roseus 695; rubicundulus 695; sal-moneus 695; salmonicolor 695; salmonicolor var. polymyxa 695; shibatanus 695; tenuis 695  
 Sporocybe azaleae 215; byssoides 20  
 Sporodesmium antiquum 21, 215; concinnum 21; conglobatum 21; hysteroideum 21; lepraria 21; pe-ziza 21  
 Sporonema phacidiioides 626  
 Sporormia herculea 595, 599; minima 595, 599  
 Sporotrichum 634; Bombacinum 14; quercuum 215  
 Stachybotrys 634  
 Stagonospora agrostidis 502; are-naria 502; bromi 502; foliicola 500-501; graminella 501-502; in-sularis 502; simplicior 500; smo-landica 502; vexatula 501  
 Staheliomyces 45  
 Staphylococcus aureus 405-406, 409  
 Steccherinum 634; ochraceum 213  
 Stemonitis 143, 208; axifera 141, 146, 153-155, 157, 166, 170; fer-ruginea 166; flaccida 166, 168; flavogenita 146, 166; fusca 143, 146, 157, 166, 170; fusca var. rufescens 166; obtusata 162; splen-dens 146, 157-158, 166, 170; splen-dens var. flaccida 166  
 Stemphylium 634  
 Stereosorus monochoriae 256  
 Stereum 21-22, 634; frustulatum 213; hirsutum 213; lobatum 213; rameale 213; subpileatum 226  
 Stictis quercifolia 211  
 Stigmathea rubicola 210  
 Stilbella ostracogena 215  
 Stilbum aurifilum 21; erythrocephalum 22; parvulum 22; rhodis 22; tomentosum 22  
 Streptomyces 235; griseus 10, 388-390, 395-397; lavendulae 235  
 Streptothrix atra 21  
 Streptotinia 633

- Strobilomyces* 491; *confusus* 214; *floccopus* 214  
*Stromatinia* 633  
*Stropharia* 634; *ambigua* 361  
*Stysanus* 634  
*Suillus* *aeruginascens* 476; *americanus* 472; *bovinus* 488; *granulatus* *ssp.* *snellii* 214; *Grevillei* *var.* *Clintonianus* 476; *punctipes* 214; *subaureus* 214  
*Synchytrium* *acidoides* 208; ***sambuci*** 25-27  
*Synsporium* 634  
*Systremma* 118  
  
*Tapesia* *fusca* 211; *riccia* 211; *torulae* 211  
*Taphrina* *caerulescens* 103, 126; *carnea* 702; *janus* 702; *lata* 702  
*Tegillum* 525  
*Teichospora* 571, 583, 633; *praestipa* 589, 592  
*Terrostella* 57, 228  
*Tetracoccosporium* 634, 636  
*Thelophora* *vialis* 213  
*Thielavia* 553-556, 558-560, 633; *basicola* 553, 555, 558-560; *terricola* 553-554, 556  
*Thielaviopsis* 554, 559; *basicola* 553, 557, 559-560  
*Thraustotheca* 178  
*Thyronectria* *austro-americana* 117  
*Tilletia* 254; ***alopecuri*** 252, 254; *youngii* 254  
*Tilletiopsis* 699-701  
*Tolyposporium* *bullatum* 268  
*Tomentella* *coriaria* 213  
*Torrendia* 40  
*Torrubiella* 304, 306-307, 310; ***confragosa*** 305-306, 310; *gonyleptica* 304-305; ***liberiana*** 306, 308, 310; ***pulvinata*** 303-305, 310; *rubra* 305-306  
*Torula* 634; *binalis* 21; *Fuckelii* 21; *herbarum* 21  
*Trametes* 443, 634; *connata* 452; *hispidus* 452; *subrosea* 363  
*Tranzschelia* 217  
*Trechispora* 634  
*Tremella* 634  
*Tremellodendron* 448; *candidum* 212; *merismatoides* 212; *tenax* 212  
*Tremellodon* *gelatinosum* 212  
*Tremellogaster* 42  
*Trichaster* 50, 57, 228  
*Trichia* *affinis* 145, 147, 155, 170; *Botrytis* 166; *contorta* 166; *fallax* 167; *favaginea* 145, 155, 167, 170; *floriformis* 167; *fragilis* 166; *lateritia* 167; *persimilis* 167; *pusilla* 167; *pyriformis* 164; *rubiformis* 164, 167; *scabra* 145, 167  
*Trichoderma* *lignorum* 14  
*Trichoglossum* *walteri* 211  
*Tricholoma* 634; *equestre* 214  
*Trichophyton* 634; *gypseum* 291-292, 296, 298-299, 301; *interdigitale* 301; *mentagrophytes* 128-130, 133, 138-140, 291-300; *purpureum* 301; *rubrum* 291-301; *violaceum* 293  
*Trichosporium* 19, 634  
*Trichothecium* *griseum* 13-14; *roseum* 14  
*Trimmatostroma* *americana* 23  
*Trinacrium* *subtile* 245  
*Tritirachium* 634  
*Trogia* 634  
*Truncocolumella* 40  
*Trybliopsis* 60; *Pinastri* 60  
*Tubercularia* 544; *menispermii* 23; *nigricans* 23; *vulgaris* 23  
*Tubifera* 141-142; *ferruginosa* 141, 145, 157-158, 167, 170  
*Tubulina* *cylindrica* 167  
*Tulasnella* 217-218, 634; *anceps* 217; *lilacina* 217  
*Tulostoma* (= *Tylostoma*, *a.v.*) 53  
*Tylophilus* *alboater* 214; *eximius* 214; *felleus* 214; *felleus* *var.* *minor* 214  
*Tylostoma* (*see* *Tulostoma*) 57, 228  
*Tympanis* 59-64, 66-67, 75; *amphibola* 59; *amphiboloides* *var.* *hypopodiza* 62, 64-65, 70, 72, 76; *bacillifera* 59; *Buchsii* 60; *confusa* 59, 62, 64-66, 70-71, 75-76; *farinacea* 60; *hypopodia* 59, 61-62, 65-67, 72, 75-76; *laricina* 601; *Pinastri* 60, 67, 74; *pithya* 59-62, 65-69, 72, 75, 211; *sepiaria* 59; *Tautziana* 59  
*Typhula* 634  
  
*Uleomyces* 548  
*Uncinula* *salicis* 210  
*Ungulina* 634  
*Uredinella* 434; *coccidiophaga* 434  
*Uredinopsis* *macrosperma* 212  
*Urnula* 649  
*Uromyces* 434; *aleuropidis-repentis* 524; *Fabae* 434; *hedydari-paniculati* 212; *proeminens* 524; *salsolae* 524  
*Uropyxis* *amorphae* 524  
*Ustilago* 255, 257, 259; *arundinellae-hirtae* 260; *avenae* 256; *cordai* 261; *crameri* 256; *crus-galli* 256; *cynodontis* 256; *digitariae* 252, 266-267; *eleocharidis* 255; *emodensis* 257, 259; *esculenta* 259; *foliorum* 261; *formosana* 266;

- hordei 259; isachnes 262; ischaemikoensis 263; kollieri 259; kusanoi 259; neglecta 259; nuda 259; oliveacea f. pseudocyperi 265; overeimi 266-267; polygoni-senticosi 262; rosulata 257; scitaminea 260; shimadae 260; shiraiana 260; sorghicola 263; sparsa 260; sphaerogena 260; tanglinensis 263; treubii 257; tritici 260; tuberculiformis 261; utriculosa 261  
Ustulina vulgaris 210  
Valsa 114; ambiens 114, 126; ceratophora 210; pini 210  
Valsaria 114; rubricosa 114  
Vararia 634  
Venturia 218  
Venturiella 571  
Vermicularia compacta 22  
Verticicladium 634  
Verticillium 634  
Volutella 215, 634  
Volvaria 634; bombycina 491; **flaviceps** 490  
Wynnea 649; americana 649-651  
Wynnella 660-661, 671  
Xanthochrous 634  
Xanthoconium affine 214  
Xenosporium 634  
Xenostele indica 523  
Xerocomus subtomentosus 214  
Xylaria 91, 108, 110, 125, 633; comosa 92; cubensis 92; grammica 92; guayanensis 92; Hypoxylon 110, 126; ianthinovelutina 210; multiplex 92; rhizomorpha 92; scopiformis 92; scruposa 92  
Xylobotryum 111; andinum 111  
Xylophallus 45  
Ypsilonia 563-564; **corticalis** 561-562, **563**-564; cuspidata 563-564; vagans 563-564  
Ypsilospora 525  
Zukalia vagans 563  
Zygodesmus 218, 634; bicolor 21; fuscus 21

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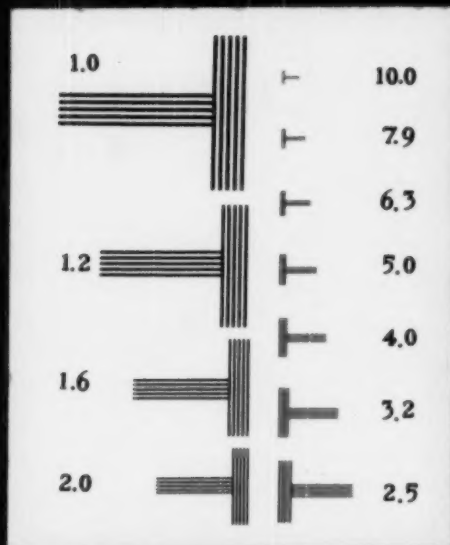
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